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Experiences and Suggestions Relating to the Preferred Numbers System

by

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An abstract of a paper presented at the annual meeting of the Standards Council of the American Standards Association, December 11, 1930

Various papers and discussions on preferred numbers date back quite a number of years, and the table recommended by the American committee was formulated in June, 1927. Considering this, it seems that the progress made in the application of the system and in its popularization has been rather slow. Much of this undoubtedly is due to the difficulty always experienced in displacing deeply rooted existing standards and to the heavy expense usually involved in a change from one standard to another. Furthermore, it seems that in various standardization activities completed since 1927 the deliberations had progressed so far that the committees considered it inadvisable to start all over again in order to introduce the preferred system when it was brought to their attention. These and similar conditions are unavoidable and more or less self-evident and, therefore, do not need to be dwelt upon at any length.

It may be helpful, however, to discuss three vital questions in the light of previous experiences with the system. These are:

Do the preferred numbers as proposed serve our conditions in the best way possible, or should they be changed or possibly supplemented?

Assuming the existence of a satisfactory table or tables, what are some of the technical difficulties in their application and what steps can be taken to overcome such difficulties?

Are there any cases which do not seem to present any particular technical difficulties, and what steps can be taken to stimulate and speed up action in such cases?

In view of my connection with the Westinghouse Electric and Manufacturing Company and the fact that its principal activity is in the electrical field, my discussion will naturally pertain to experiences in this field. However, there is no question that, fundamentally, the same conditions apply in any other field of endeavor.

Part 1

With reference to the first question, it may be stated that no particular difficulty has been met with in introducing the proposed system as such wherever the decimal system could be used readily. However, we cannot escape the fact that the fractional system is so deeply rooted in this country that any system based exclusively upon decimals will be adopted very slowly. No matter what one's personal feelings may be regarding the desirability of the use of decimals, one cannot ignore this fact. Even though the engineers and manufacturers may be willing and possibly anxious to adopt the decimal system, we have to concede that there are any number of tradesmen in the country possessing rulers and other measuring equipment based on the fractional system, and unaccustomed to the use of decimals. As a result, the preferred number system either will not be used at all in many cases, or use may be made of the general principles by changing the decimals to fractions that happen to be most convenient for the case under consideration.

Being convinced of the fundamental soundness of the preferred number system, I made various attempts to inject it into the design work of the Westinghouse Electric and Manufacturing Company as well as into the work of the national committees dealing with the standardization of electrical apparatus. One example of this was in connection with the over-all and mounting dimensions of electrical machines. In this and in other cases there was at once a rather marked reaction against the use of decimals for this purpose. The manufacturers might have been converted to the use of decimals, but the committees representing the users were definitely opposed to it. Unquestionably there was some justification for their position, because the mounting of machines and apparatus is not merely a factory proposition but

5 Series	*10 Series*	*20 Series*	*40 Series*	*5 Series*	*10 Series*	*20 Series*	*40 Series*
1	1	1	1	10	10	10	10
			$1\frac{1}{16}$				$10\frac{1}{2}$
		$1\frac{1}{8}$	$1\frac{1}{8}$			11	11
			$1\frac{3}{16}$				$11\frac{3}{4}$
	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{4}$		$12\frac{1}{2}$	$12\frac{1}{2}$	$12\frac{1}{2}$
			$1\frac{5}{16}$				$13\frac{1}{4}$
		$1\frac{3}{8}$	$1\frac{3}{8}$			14	14
			$1\frac{15}{32}$				15
$1\frac{9}{16}$	$1\frac{9}{16}$	$1\frac{9}{16}$	$1\frac{9}{16}$	16	16	16	16
			$1\frac{21}{32}$				17
		$1\frac{3}{4}$	$1\frac{3}{4}$			18	18
			$1\frac{7}{8}$				19
	2	2	2		20	20	20
			$2\frac{1}{8}$				21
		$2\frac{1}{4}$	$2\frac{1}{4}$			22	22
			$2\frac{3}{8}$				$23\frac{1}{2}$
$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	25	25	25	25
			$2\frac{5}{8}$				$26\frac{1}{2}$
		$2\frac{3}{4}$	$2\frac{3}{4}$			28	28
			$2\frac{15}{16}$				30
	$3\frac{1}{8}$	$3\frac{1}{8}$	$3\frac{1}{8}$		32	32	32
			$3\frac{5}{16}$				34
		$3\frac{1}{2}$	$3\frac{1}{2}$			36	36
			$3\frac{3}{4}$				38
4	4	4	4	40	40	40	40
			$4\frac{1}{4}$				42
		$4\frac{1}{2}$	$4\frac{1}{2}$			44	44
			$4\frac{3}{4}$				47
	5	5	5		50	50	50
			$5\frac{1}{4}$				53
		$5\frac{1}{2}$	$5\frac{1}{2}$			56	56
			$5\frac{7}{8}$				60
$6\frac{1}{4}$	$6\frac{1}{4}$	$6\frac{1}{4}$	$6\frac{1}{4}$	64	64	64	64
			$6\frac{5}{8}$				68
		7	7			72	72
			$7\frac{1}{2}$				76
	8	8	8		80	80	80
			$8\frac{1}{2}$				84
		9	9			88	88
			$9\frac{1}{2}$				94
10	10	10	10	100	100	100	100

TABLE 1

Suggested Fractional Preferred Numbers—1 to 100

one which has to be handled in the field by a great variety of personnel used to the fractional system. Because of this reaction, Mr. R. Ehrenfeld[1] worked out a fractional preferred number system (see Table 1 attached), which was subsequently instrumental in the use of the preferred number idea in a number of cases.

In view of conditions previously stated and of the experiences just related, I believe that the committee on preferred numbers should seriously consider the adoption of a fractional system in addition to the decimal system, but that continued emphasis should be given to the preferment of the decimal system over the fractional system. The establishing of a fractional system seems desirable so that those insisting upon fractions will have a common ground and not be obliged to evolve several similar but slightly different systems. As to whether the fraction system suggested by Mr. Ehrenfeld is the best all-round system and whether it should be extended below one inch, I am not prepared to say. This should be carefully studied by the committee, and it may furthermore be advisable to

[1] Assistant manager, Small Motor Engineering Department, Westinghouse Electric and Manufacturing Company.

study the relation between the decimal and fractional systems with the idea of making them coincide as far as possible.

Part 2

Our second question related to the technical difficulties which may be encountered in applying the preferred number system. Among these, there are two outstanding ones:

Space, weight, or similar limitations

The interrelation of many dimensions making it difficult to standardize on a preferred number series for more than a few of them in a given design

The question of space limitations can be illustrated by the induction motor, shown in Figure 1. Let us assume that the various manufacturers have agreed among themselves that $11^1/_8$ inches is the smallest dimension for L within which they all can keep and at the same time obtain satisfactory performance for a certain definite rating. In order, then, to bring this dimension within the fractional preferred number system, it would have to be increased to $11^3/_4$ inches. Even though the increase is less than six per cent, it may be rightfully questioned whether such an increase in the space requirements for no other purpose than that of being in line with a preferred number system would be justified from an economic point of view. Assuming this to be answered in the negative, the question then arises as to whether by special efforts and possibly by some sacrifice in performance the dimension could be shortened to meet the next smaller preferred number. Since the necessary reduction of one-eighth inch is but slightly more than one per cent of the dimension under consideration, this would on first thought appear to be rather easy. We find, however, that with the dimensions a, b, c, and d assumed to be reduced to the minimum in line with safe practice, a reduction would have to be made in the core width (e). This dimension in a practical case might be in the neighborhood of $1^1/_2$ to 2 inches, and so the reduction of one-eighth inch would be from six to eight per cent, which in turn is rather appreciable and might affect the motor performance quite materially.

Nevertheless, I believe that the dimensions under discussion could be arranged to be in the preferred number series. The reason for this is that any one of the standardized frames is never used for one single rating but covers a great variety of ratings, such as continuous and short-time ratings, various speeds and frequencies, so-called Class I and Class II motors for different starting conditions, and many others. It is an obvious and fully established fact that so many ratings on a given frame cannot all be obtained ideally by any one value for a certain dimension. In other words, any dimension chosen for L would favor some of the ratings and unfavorably affect others. Therefore, when looking at this matter broadly, there is little doubt that a preferred number for dimension L would serve the industry fully as

Preferred Numbers

Standardization, like businesses and individuals, is in many ways tied to its past. Given a clear field and no traditions, standardization of any subject would be a relatively easy matter at any time. Standardization, however, is usually attempted after complications and confusion have resulted from natural and undirected development by many individuals and groups. This is especially true with development of any device or commodity where dimensional standardization might apply.

An attempt to provide a rational scheme whereby development might take place without prejudice to the evolution of that which is best and fittest has resulted in what is known as the system of preferred numbers. This system provides for a logical method of arriving at the minimum necessary number of sizes of a given device, for example, required to cover a specific field. It insures that additional sizes may be provided so that they will form a logical sequence with those already existing.

Mr. Hellmund's paper gives some striking examples of the application of preferred numbers. There is probably no manufacturing industry in the country which could not use the preferred numbers system to advantage.

It seems desirable that the informal ASA Committee on Preferred Numbers be given the status of a regular sectional committee of the American Standards Association and that cooperative arrangements with other sectional committees be established in order that the great benefits of the preferred numbers system may be utilized whenever and wherever it may be satisfactorily applied.

C. E. Skinner, *Chairman*
ASA Committee on Preferred Numbers

well as the dimension of $11\frac{1}{8}$ inches discussed. In fact, better all-round results could probably be obtained with the use of preferred numbers for this dimension, as this would bring about more logical steps between the various standard frames.

Here it is very often desirable to obtain the maximum rating possible in a given space regardless of other conditions, and such considerations are more important than being in line with a preferred number system.

More frequently, difficulties present them-

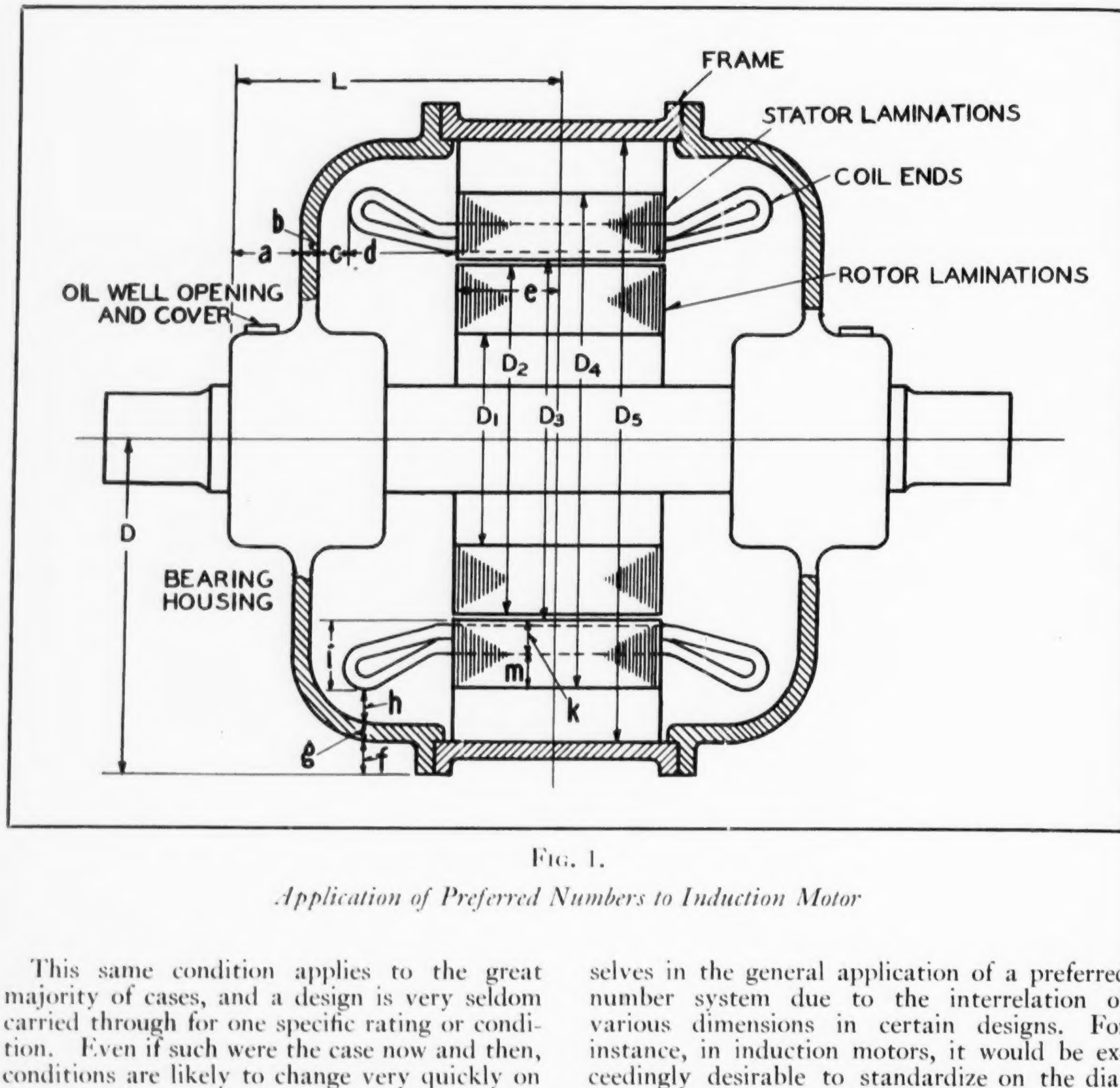


Fig. 1.

Application of Preferred Numbers to Induction Motor

This same condition applies to the great majority of cases, and a design is very seldom carried through for one specific rating or condition. Even if such were the case now and then, conditions are likely to change very quickly on account of improvements in materials used, additional design knowledge or skill, improved manufacturing conditions, etc. This means that even if the most favorable conditions with reference to size and space were realized today, they are likely to be obsolete tomorrow, and so for this reason the choice of a preferred number will very seldom impose a permanent handicap upon the industry with regard to space limitations and the like. However, it must be granted that there are some special cases, as in railway work, where space limitations are very exacting.

selves in the general application of a preferred number system due to the interrelation of various dimensions in certain designs. For instance, in induction motors, it would be exceedingly desirable to standardize on the diameters D_1, D_2, D_3, and D_4 (Figure 1) for the laminations of the stator and the rotor. The reason for this is that the manufacturers are continuously expending appreciable amounts of money for punching dies for various diameters. An attempt was, therefore, made to bring such diameters in line with the preferred number system, so far, however, with practically no results due to the following conditions: The largest inside diameter of the stator which is possible is essentially fixed by the previously standardized dimension D and the fact that the

dimensions f, g, h, and i cannot be reduced advantageously or safely below certain values. Therefore, in order to bring D_3 to the nearest preferred number, it would have to be decreased in some cases as much as five to six per cent below the possible maximum even with the use of the 40 series. Since with smaller motors the rating varies in proportion to more than the square of the diameter, this would mean that a rating reduction as great as 15 per cent might be involved, or else the performance of the motor would be seriously affected. (The use of the 80 series would improve this condition, but it would introduce so many standard diameters that it would largely defeat the purpose of standardization.) Thus the designer trying to adopt the preferred number system would handicap himself considerably in competition with a designer not so limiting himself. Then, again, if the inside diameter of the stator were chosen to be a preferred number, the outside diameter D_2 of the rotor could not be so chosen because the air-gap of induction motors is in all cases smaller than the smallest step in any reasonable series. The outside diameter of the stator punchings, D_4, is usually determined by making k and m as small as possible. The choosing of a diameter larger than necessary in order to meet the next larger preferred number would frequently be satisfactory from a design point of view, but it would necessitate the use of larger sheets from which the punchings are made. This in turn would frequently lead to an economic waste not justified by the advantages of living up to the preferred number system and the reduction in tool expense which would result therefrom.

Another point entering into this general problem is the desirability of adopting preferred numbers for the sheet sizes from which these punchings are made (Figure 2). Under practically all conditions it was found that if the outside diameter D_4 were chosen from the preferred series, the sheets from which the punchings were made could not be from the preferred series without involving an undesirable amount of scrap. Quite an extensive study would be necessary to determine which of the two factors should be given preference in order to obtain the maximum economy.

Nevertheless, cases like this may not be entirely hopeless and may be worth while considering when undertaken under somewhat more favorable conditions. The question of punching diameters also enters into the design of commutating and synchronous machines, where the interrelation of punching dimensions is not quite so involved. Figure 3 shows a number of curves in which the diameters of the punchings are plotted on semi-logarithmic paper, both for some older lines and for some lines which have been brought out since the advantages of the geometric series were appreciated. It will be seen from these curves and points that it is possible to follow a geometric series to good

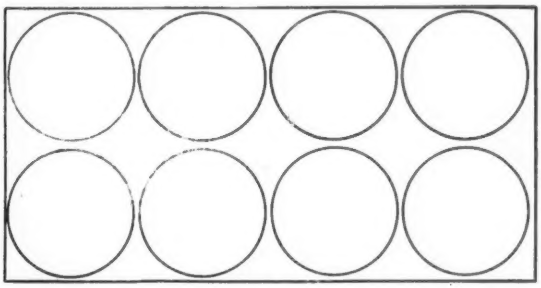


FIG. 2.
Sheet Steel Blank

advantage. Even the newer lines shown here are not in accord with the preferred series, but this is due to the fact that certain dimensions had been previously settled and that the advantages which could be gained with the standard preferred numbers were not sufficient from an economic point of view to counterbalance the losses involved in scrapping existing tools and making obsolete the existing drawings and experience.

The induction motor condition described is of course rather involved, but it is a good illustration of the many problems introduced by the interrelation between the dimensions in design work. Similar questions arise, however, in many much simpler cases. It is at once evident, for instance, that in the case of a bolt in a clearance hole, it will be impossible to have both the hole and the bolt on a preferred number basis without making the clearance excessive, although good reasons can be advanced why either of the two dimensions could be standardized to good advantage on a preferred number basis. Again, when it comes to finished materials, the question arises of whether the finished article or the unfinished stock sizes should be chosen from the preferred series; too much stock would have to be machined off in many cases if both dimensions were chosen from the series. Even the question of tolerances enters into the problem.

What conclusions can now be drawn from these previous considerations? One thing is most evident, and that is that the engineer is not confronted merely with the problem of adopting the series, but first of all with the necessity of studying carefully which of the dimensions in a given design should be chosen from the series in order to accomplish the maximum economic results. Then, too, wherever there is hope of having several of the dimensions from the preferred series, he must decide which

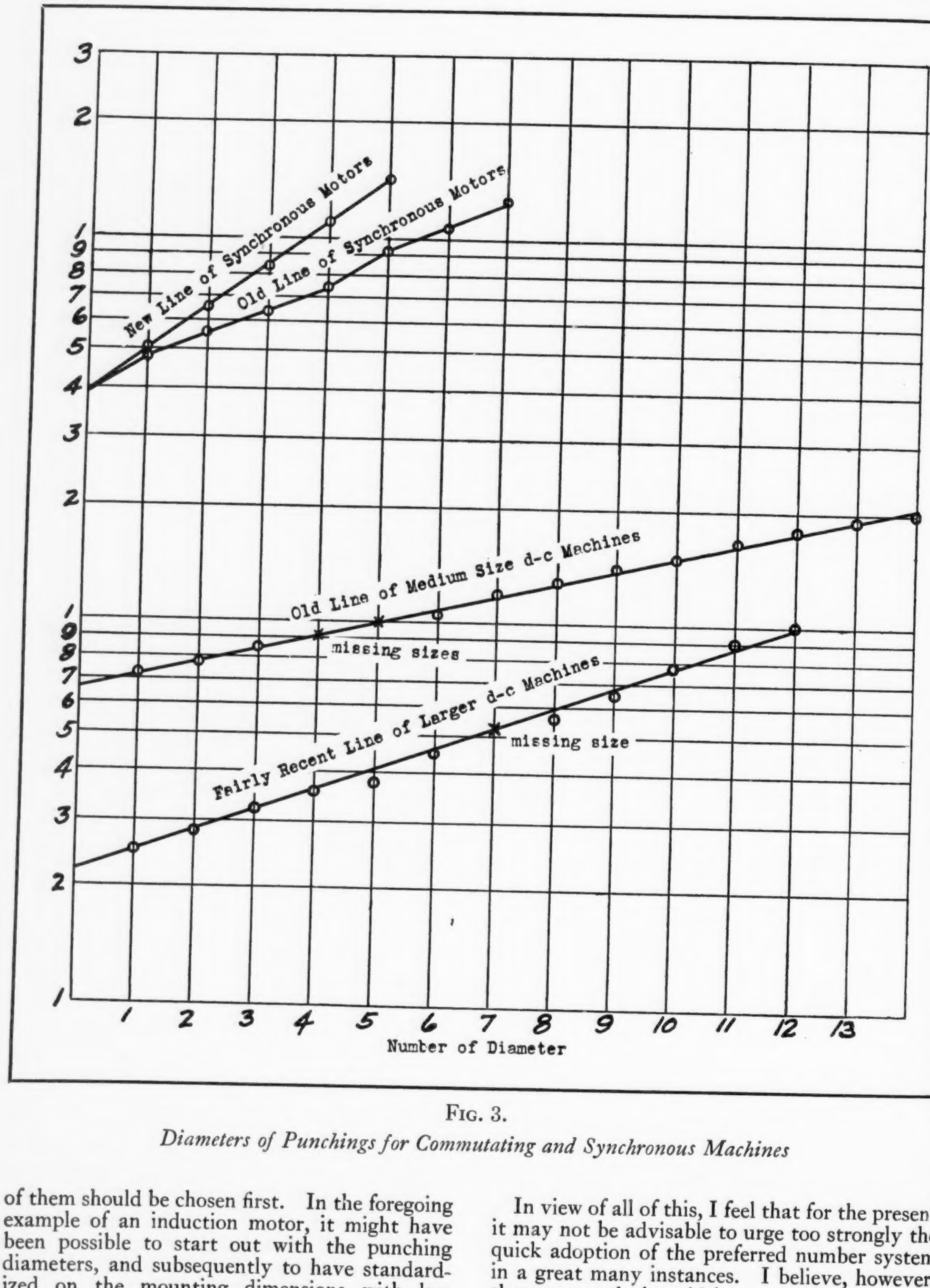


FIG. 3.

Diameters of Punchings for Commutating and Synchronous Machines

of them should be chosen first. In the foregoing example of an induction motor, it might have been possible to start out with the punching diameters, and subsequently to have standardized on the mounting dimensions with less handicap to the final result than was obtained with the reverse procedure.

In view of all of this, I feel that for the present it may not be advisable to urge too strongly the quick adoption of the preferred number system in a great many instances. I believe, however, that a great deal could be accomplished toward the final result if it were suggested to the various standardization agencies that they study first of

all which dimensions in their products, if any, could preferably be based on the preferred number system. Such studies carried on by the various standardization bodies would assist greatly in spreading the idea of preferred numbers and facilitate their adoption when an opportune time presents itself.

Part 3

The third question which I thought to discuss was that of whether there are any cases subject to preferred number standardization which do not present great technical difficulties. It seems to me that there are a great number of such cases in connection with nominal ratings of machinery and apparatus. In the standardization of ratings, we do not run into the difficulties presented by the parallel use of decimals and fractions, and can without any great difficulty apply the decimal system. Furthermore, the interrelation of figures met with in dimensions is present only in exceptional cases where ratings are concerned. Referring again to the standardization of electrical motors, Table 2 shows the present standard ratings and also the nearest figures in the 5 series up to 16 horsepower, and from there on in the 10 series. The 5 and 10 series as indicated gives one less rating over the same range and, in spite of this, with less maximum spacing between the ratings. In the lower range of the present standards the maximum spacing is 66.6 per cent, while with the 5 series it is 60 per cent. In the upper range, the maximum spacing of the present standards is 33 per cent, while with the 10 series it would be only 25 per cent. There might be some question as to whether ratings such as 16 horsepower could be as readily adopted as 15 horsepower. In this connection reference might be made to the ratings of the old carbon lamps, where the rating of 16 candle-power was in use for many years. It is needless to say that the standardization of horsepower ratings on a preferred number basis could also be applied to gasoline engines, Diesel engines, steam engines, steam turbines, etc., whenever new standardizations are undertaken. The use of the system should further be advocated in the case of watts, kilowatts, and kilovolt-amperes as relating to such apparatus as lamps, generators, transformers, etc.

In a-c generators there is an interrelation of ratings due to the fact that they are rated on both a kilowatt and kilovolt-ampere basis. However, there is some leeway in the power factor on which the kv-a ratings can be based, and if it is made a practice to base the kv-a ratings on power factor values approximating the 10 and 20 series, it will be found possible to base both the kw and kv-a ratings for the same machine on the preferred number system. It so happens that the standard power factor used for ratings by NEMA is .8, a figure which is in the 10 series. This eliminates any difficulty in having both the kw and kv-a ratings in the preferred number series.

Similarly, it is found that transformers of various kinds could be readily rated by the use of the 5 and 10 series.

Table 3 shows the lamp ratings as at present standardized compared with the possible preferred number ratings. It will be noted that the best choice for the latter first follows the 5 series; then for some distance, covering the more popular ratings for lamps, it follows the 10 series; and finally, for the less popular high ratings, goes back to the 5 series.

Present Standards	*5 Series*	*10 Series*
1	1	
1.5	1.6	
2	2.5	
3	4.0	
5		
7.5	6.4	
10	10	
15	16	
20		20
25		25
30		32
40		40
50		50
60		64
75		80
100		100
125		125
150		160
200		200

TABLE 2

Large Motor hp Ratings

Considerable advantage, without any undue technical difficulties, would result from the use of the preferred number system for the standardization of current ratings on all series-connected apparatus. Examples of this type of apparatus are magnetic contactors, small air circuit breakers, large circuit breakers of various types, fuses, thermal cutouts, knife and disconnecting switches, snap switches, watthour meters, and current transformers.

A comparison of the present standard ratings for these devices with the 5 and 10 series indicates that no difficulty would be encountered in using these series for the ratings in future

Standard Watts	*5 Series*	*10 Series*
15	16	
25	25	
40	40	
50		50
60		64
75		80
100		100
		125
150		160
		200
200		
	250	
300		
	400	
500	640	
750		
1000	1000	

TABLE 3
Lamps

standardization activities. Nearly always the addition or elimination of one or two of the steps in the entire range of ratings and the use of the series would bring about lines with uniform steps smaller than the maximum steps in the present standards. There may be some doubt regarding the use of the standard series for the thermal cutouts. The present ratings follow a geometric series with steps of about 20 per cent. As to whether it would be possible to change to the 10 series with steps of 25 per cent, and at the same time adequately protect the motors with which these thermal cutouts are used, would have to be carefully investigated. On the other hand, the use of the 20 series would mean an appreciable increase in the number of ratings. This, therefore, represents one case in which the advisability of adopting the preferred number series is doubtful, although a geometric series is now used to good advantage.

A change to the preferred number system for the current ratings of series-connected apparatus would result in the obvious advantage of having all such apparatus rated on the same basis; in fact, the preferred number system seems to be the most promising vehicle for bringing the various committees and manufacturers together.

I wish to emphasize that I am not advocating an immediate adoption of preferred numbers for all these purposes, because the advantages gained thereby would not be sufficient to outweigh the disadvantages in upsetting existing standards and the expense involved in so doing. However, changes in standards are continually taking place for other reasons, and whenever this is the case, changing to the preferred series should always be considered. It also seems possible that, whenever a complete revision of a line is not advisable at any one time, a gradual working toward the preferred series could frequently be accomplished. In many of the cases studied, a change of one or two ratings would be sufficient to bring the whole line, or at least the greater part of it, substantially in accord with the preferred number series.

Although the examples previously cited relate to the electrical industry, I have no doubt that similar standardizations could be accomplished in other industries. For example, the capacity of blowers and pumps and possibly also the pressure ratings could be based on the preferred number series.

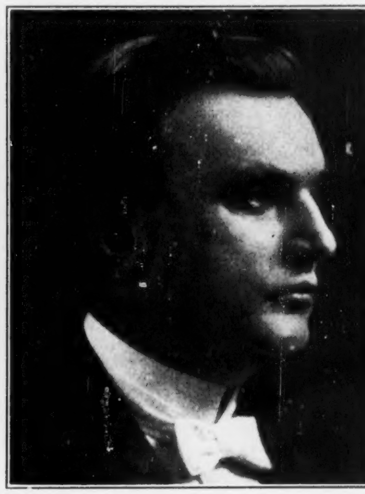
In order to bring all this about whenever suitable opportunities present themselves, it would be necessary to interest the various standardization committees in the possibilities just cited. One definite suggestion is that each of the interested committees be requested to appoint one member to study the possibility of adopting preferred numbers for ratings. In the case of electrical current ratings, which enter into the work of a great many committees, it could probably be arranged to have these especially appointed members of the various committees meet for the purpose of discussing the advantages of eventually adopting preferred numbers. I am convinced that considerable progress would be made if these and similar steps were taken in the near future, as in this way all of the committees would have the question of preferred numbers brought to their attention whenever new standardizations are under consideration.

Discussion

DR. JEFFRIES: I happen to have worked with the committee trying to establish the wattages (of electric lamps) up to 100, in what is known as the ideal system, and the list given in the blue-print in Table 3 (15, 25, 40, 50, 60, 75, 100) does not properly represent the industry. It represents types that are available, but really not the production practice. The production is essentially 15, 25, 40, 60, and 100 watts, with the 50 watt thrown in only because the central stations were in the habit of using it, and the 75 watt put in because it was an old type for which there was some demand; but the lighting service

Photo by Blank-Stoller, Inc.

F. H. Hardin



E.T. Wood

Radio Corporation of America

Alfred N. Goldsmith

W. S. Paine

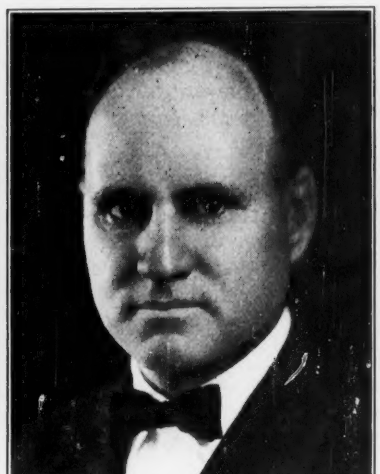
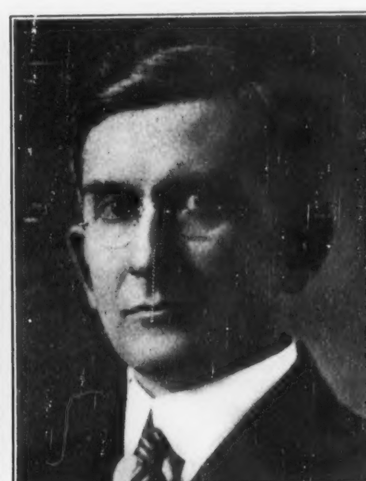


Photo by Blank-Stoller, Inc.

Zay Jeffries



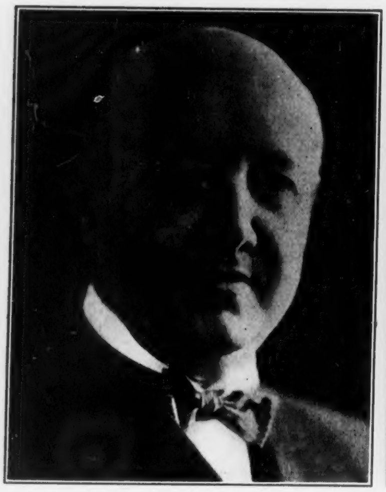
Lewis K. Sillcox

New Members of the ASA Standards Council

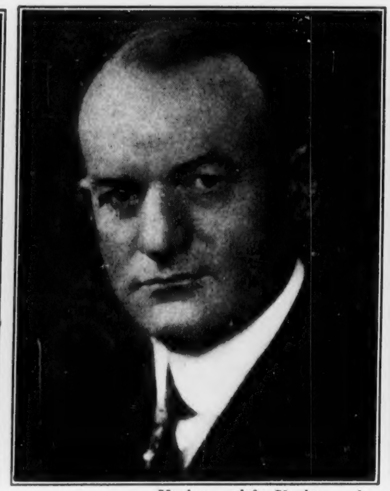
Mr. Hardin, assistant to the president of the New York Central Railroad, represents the Mechanical Division of the American Railway Association; Mr. Wood, Wheeling Steel Corporation, represents the Association of American Steel Manufacturers Technical Committees; Dr. Goldsmith, vice-president and general engineer, Radio Corporation of America, represents the Institute of Radio Engineers; Mr. Paine, Engineering and Inspection Department, Aetna Life Insurance Company, represents the National Bureau of Casualty and Surety Underwriters; Dr. Jeffries, Aluminum Company of America, represents the Light Metals Group; Mr. Sillcox, vice-president, New York Air Brake Company, represents the American Society of Mechanical Engineers.

can all be supplied with those wattages, and it is interesting to see that they fall almost exactly in the 5-series and not by design. That represents 50 years of experience. It seems to be only another example of how size dimensions determined by experience will tend to comply approximately with the series of preferred numbers.

As we begin to analyze the problem a little further, we find that to use preferred numbers



F. E. Moskovics



Underwood & Underwood

L. A. Downs

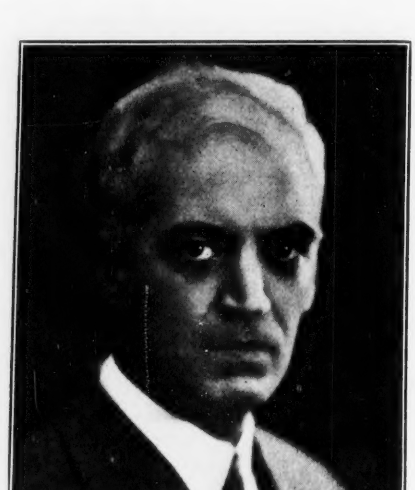
Quincy Bent

Re-appointed to ASA Board of Directors for 1931–1933 term

Mr. Moskovics, president of the Improved Products Corporation, was designated by the Society of Automotive Engineers; Mr. Downs, president of the Illinois Central System, was designated by the American Railway Association; Mr. Bent, vice-president in charge of manufacture of the Bethlehem Steel Company, was designated by the American Society for Testing Materials.

correctly requires careful judgment, thus, in the example given, we have compared the wattage with the preferred numbers, but as a matter of fact with the 15 watt lamps there is an efficiency of 9 lumens per watt approximately, and with the 100 watt of 16, or thereabouts. Then, candle-power values if plotted would not fit any of these series but would approximately agree with still another geometric series. Likewise, the diameter of the bulb would fit approximately only a portion of the 40-series but would not fit exactly any series given here. However, there are a good many other factors in connection with the lamp, I should say about 15, each of which will approximately fit into a series of preferred numbers, but no two of which can utilize the same series.

So I think that the lesson we have gained from studying this subject is that the sizes of almost any kind of device may be expanded or reduced, as the case may be, approximately in accordance with the preferred numbers, but that a considerable variety of series may be necessary in order to make the process wholly applicable. Furthermore, the need for using good engineering judgment is always present and preferred numbers do not provide an automatic method here for doing the engineering.



John C. Parker

Vice-president of engineering, Brooklyn Edison Company, who was elected vice-chairman of the ASA Standards Council at the meeting of December 11, 1930.

Mr. Stepanov: The preceding speaker said that we need several series to apply to different cases. That is right, and that means that we need to use different orders of preference. The difficulties mentioned—that dimensions and ratings are often such as to be very difficult to adjust to this system—I do not consider serious, and think it usually practical to utilize the values corresponding to preferred numbers. We find then that, if we take some main dimension of the product and know the relations of that with other properties, we will find that the other properties and dimensions will follow geometric series corresponding exactly to preferred numbers but in different orders of prefer-

ence. If we take the main dimensions as in a series with a given ratio we usually find some other dimension following preferred numbers also but not necessarily the same series. The operating values, horsepowers, capacities, etc., are connected with the main dimension always in some such way that they fall in a series which is some power of the fundamental dimension series. Thus if the law of similitude is established, values can nearly always be adjusted to the preferred numbers table and so far as I know in almost any kind of engineering design such a relation can be set up.

I would like to stress here another point. Until recently the subject has been discussed mainly from the theoretical point of view and to a limited extent. Few people are familiar with the preferred numbers idea. It seems to me, therefore, that the next work of standardization in this field is to increase the publicity on the practical aspects on the problem and to this end it may be that technical societies and technical magazines will open pages in their journals under the heading "Preferred Numbers Series" or some such term, where everybody interested in the subject could put questions and have them answered and so obtain a continuous public discussion of the question. The idea of obtaining practical applications will not be difficult and would tend definitely to increase interest in the subject and encourage individuals to spend time in its study. Then engineers will see advantages in the system, whereas before it has been only a theoretical study having no evident usefulness. Another possibility is that the Standards Association might send out questionnaires to all manufacturers, the questions to be formulated in such a way that to answer them it would be necessary to become conversant with the subject. Then everyone will find for himself advantages and difficulties encountered in the application of the system, as, for instance, in answering such a question as "How many sizes are there now for this product? How many would there be if the gradation were according to preferred numbers?" In this way, many would come to see the practical significance of the subject and the possibilities it has for savings in their own industry.

Standard for Track Bolts and Nuts

The new American Standard for track bolts and nuts (B18d-1930) has been printed and may be purchased at 40 cents per copy from the ASA Information Service.

A discussion of the new standard was published on page 38 of the December, 1930, issue of the ASA BULLETIN.

A.S.M.E. Paper on Transmission Shafting

An important paper bearing on the Code for the Design of Transmission Shafting (B17-1927) and including other material of value to machine designers, chief draftsmen, and others responsible for calculation of stresses in machine parts, appears in *Transactions of the A.S.M.E.*, January-April, 1930, Vol. 52, No. 11. The paper, called "Factor of Safety and Working Stress," is by C. Richard Soderberg of Vesteras, Sweden.

The author proposes that the engineering profession should develop a general code on the subject of management of working stresses in calculation and design. The paper was prepared in connection with the activities of the author on a committee on mechanical calculations at the Westinghouse Electric and Manufacturing Company. Included in the paper is a code for determination of working stresses used by the East Pittsburgh works of that company. A copy of this paper is available for loan to any organization interested.

New A.S.M.E. Power Test Code

The American Society of Mechanical Engineers has recently issued a new power test code—the Test Code for Liquid Fuels. This code covers the standard methods for determination of those ascertainable chemical and physical properties which serve as indicators of the value of liquid fuels extensively used in the generation of heat and power. The code also includes methods of determining the efficiency of the combustion process.

This code is one of 24 test codes published by the A.S.M.E. The price is 30 cents per copy and it may be obtained from the Publication Department, the American Society of Mechanical Engineers, 29 West 39 Street, New York City, or through the ASA Information Service.

Convention Adopts Refrigeration Code

The ASA Safety Code for Mechanical Refrigeration (B9-1930) was adopted by the National Association of Practical Refrigerating Engineers at its last convention at Memphis, Tennessee. At this time several chapter delegates from various cities requested copies of the code so that they might present them for adoption by the local chapters and also bring them to the attention of the city officials concerned.

National Standards Council, Inc., Organized to Certify Consumer Goods

Labels to be issued by new body for use on products complying with standard specfications; enforcement of standards planned

Member-Bodies and Sustaining-Members of the American Standards Association will be interested in the announcement made in Washington on January 14 that the National Standards Council, Inc., has been organized and incorporated in the District of Columbia "to promote and insure the adoption and practical application of standards for consumer goods..." The Council proposes to issue a standard mark or insignia to identify and guarantee products manufactured in accordance with standard specifications. It is to be financed through the sale of its labels to manufacturers for affixing to standard products.

The organization will not establish standards, but will "certify and enforce standards adopted and promulgated by any responsible group, organization, or government bureau."

The announcement, which appears to be a preliminary one, does not indicate what provisions the Council has made for testing and inspection. Neither is it indicated how the acceptability to consumers of the standards controlling the products is to be assured.

NOTE. It will be recalled that upon requests of the National Electrical Manufacturers Association and American Home Economics Association, printed in the August and September, 1930, issues of the ASA BULLETIN, the ASA Board of Directors has authorized a thoroughgoing study of the subjects of certification and labeling by a committee of the Board. (See page 24, ASA BULLETIN, November, 1930.)

The following is an abstract of an address by A. F. Allison, President of the National Standards Council, Inc., which contains a description of the general purpose of the organization. The address was presented before The Broom Institute at its organization meeting on January 14:

Making Commodity Standards Useful to the Consumer

Standardization is no new or untried idea.

Over two hundred and fifty years ago, Sir Josiah Child, a London merchant, writing in the year 1665 gave as one of the important reasons why the Dutch were then successfully challenging British trade supremacy:

> "Their exact making whose standards are so well known that merchants will buy without opening."

What is standardization?

The dictionary tells us that to standardize is:

> "to determine the strength, scale value, etc., by comparison with some standard."

This definition does not make uniformity a requirement of standardization. Comparison is the important factor, and comparison is, of course, impossible, without some basis of measurement or description.

The three blind men who went to "see" the elephant, one feeling only the elephant's trunk, another only the elephant's legs, and the third, the elephant's tail, each describing the elephant later as he "saw" it, were no wider of the mark than many a consumer-buyer today trying to arrive at a sensible basis for selection and purchase of commodities.

Elephants need not be uniform in color, or in size, but every elephant has certain standard characteristics. If you know the standard description of an elephant, you will not be fooled into buying a rabbit, thinking you've got a bargain elephant.

There has been a good deal of misunderstanding and misinterpretation of the meaning and practical purpose of standardization, as applied to consumer goods, which are commodities, such as brooms, blankets, garments, etc., ready for consumer use.

Standardization, as we are now applying the term, simply is a method whereby merchandise can be broadly graded into two classifications: Standard and Sub-Standard. It should not and does not imply that all standard goods shall be made exactly alike. It does establish a broad specification or description which represents a minimum standard, and goods that do not equal or exceed these minimum specifications are sub-standard.

In an interview published by the *New York Times* last November 23, I stated:

> "Taking the majority of lines of merchandise sold over the retail counter to

consumers, it is probable that in no case is the percentage of sub-standard goods less than 10% of the total and from this the percentage may easily run as high as 60%.... The sale of sub-standard goods, not identified as such when offered to the consumer, not only displaces an approximately equal volume of legitimate merchandise, but also exerts a tremendously depressing influence upon marketing conditions involving all the many varieties of unfair competition."

Since the appearance of this interview in the *New York Times*, I have heard from many manufacturers, retailers, and consumers who agree with my estimates as to the volume and marketing effect of sub-standard goods. Several of my correspondents told me that, in their judgment, few industries would show a percentage of less than 35 per cent sub-standard goods.

Over-production, in many industries, is frequently said to be the cause of bad business conditions. Whenever there is evidence of strong, sustained demand for any article, manufacturers in that line increase their production, and new factories are equipped and soon add to the available supply. As production begins to overtake the demand, competition grows keener, price reductions are made to maintain volume, sharp practices become the rule instead of the exception, and down goes the market into the quicksands of fake values and fake goods.

The broom industry, like many others, today faces a general condition of this kind.

Yet, in all probability, if the entire market for brooms could be surveyed, and if an analysis could be made showing exactly the number of dozens of each type of broom required to meet the present demand, the production of brooms of standard or better than standard quality would prove to be less than 60 per cent of the total requirements.

Sub-Standard Product Sold

In other words, sub-standard brooms, sold because falsely represented, have absorbed fully 40% of the market which should be open to the manufacturers making brooms of at least minimum standard quality.

There can be no stabilization of market conditions in your industry as long as you permit the sub-standard producers to operate without check or hindrance.

Destructive competition is a disease that spreads without effective resistance throughout an industry which has failed to establish the protection of nationally recognized standards for its goods.

You have many practical reasons to appreciate the possibilities and necessity for a standardization program in the broom industry.

Among other statements made to me repeatedly by a dozen or more representative broom manufacturers are the following:

1—Your factory capacity is greater than present demand;
2—You have an intolerable burden of prison competition, which represents about 1/3 your total production;
3—The percentage of sub-standard brooms made and sold is steadily increasing, and as volume of sub-standard goods goes up, your earnings go down;
4—Speculative purchases of raw materials no longer offer you good opportunities to maintain earnings to off-set decline in manufacturing profit.

Standards Aid Many Industries

Your problems are not unique. Many other industries are facing exactly the same conditions. And standardization is rapidly being accepted by practically all industries as the one best way to overcome many of their long-standing difficulties.

There has been a great deal of research work, and much progress made in the field of standardization. This has all been constructive and valuable.

But, particularly in respect to consumer goods, standardization programs have not yet been made fully effective. For several years, the problem of how best to make standardization reach the consumer, and thereby benefit the competent manufacturer and distributor, has been the subject of careful study and analysis.

As a result of these studies, and also because of the need for coordinated research, investigation and analysis of similar marketing problems in a wide range of industries, National Standards Council was organized and incorporated in January, 1930, as an educational society under District of Columbia charter. Government officials, marketing specialists, economists, engineers, legal specialists, merchants, manufacturers, and others whose experience and training made their advice and suggestions valuable, were freely consulted and, without exception, strongly approved the purpose and program of National Standards Council.

Membership in National Standards Council is only by invitation extended by the Board of Trustees. There are no membership fees or dues. The organization, by the terms of its charter, is forbidden to engage in any of its objects or purposes for profit. No part of the income of the organization may "inure to the

benefit of any of its members or trustees, and no member, officer, trustee or employee shall receive any pecuniary profit of any kind"... from any operations of the Council..."except reasonable compensation for services..."

What services does National Standards Council make available to you, in the event that you establish satisfactory broom standards?

You are individual manufacturers of brooms, competing with each other in the sale of your product. As members of The Broom Institute, you continue to be competitors.

You may and should agree with one another as to the detailed specifications of The Broom Institute Standard. Your action on your standard becomes a matter of record.

Labeling Recommended

But, merely to announce your standards, even publishing them broadcast, will not be sufficient to make your standards reach the consumer, and your standardization program will fall far short of its possibilities if you do not make it easy for the consumer-buyer to purchase standard brooms.

Obviously you need a plan and method for labeling your standard brooms so that merchants and consumers can buy in confidence that they are fully protected against fraud or misrepresentation.

If you undertake, individually or collectively, to establish public recognition and confidence in a standards guarantee label, issued and backed only by your group, and serving only your selfish interests, you will find it necessary to risk the expenditure of large sums of money in advertising and promotion work over a period of years, in an effort to educate the merchant and consumer-buyer and secure buyers' acceptance for your guarantee.

If you do not adopt a group label or mark, under regulations that make for adherence to the standard; if each one of you proposes to use his own label only, with the addition of a standards guarantee, you will be worse off, in a short time, than you are today.

The Trustees[1] of National Standards Council have had an unusual opportunity to analyze practically every standardization program, or at least all important activities along this line, with special reference and attention to consumer goods.

We have come to the following conclusions in regard to the practical procedure necessary to make standardization reach the consumer:

1—There must be a standard certification label, tag, or mark attached to each article, in a form to insure easy identification at the time purchase is made by the consumer-buyer;

2—These certification labels will be most effective when issued by an impartial, non-profit making agency only under specific terms of a license or contract with each individual manufacturer, with provision for sufficient and certain penalty for any misrepresentation;

3—To reduce, rather than to increase, selling expense is a prime purpose of certified standard labels. Thus, National Standards Council has given special attention to the possibilities of providing certified label service at a minimum of cost. The issuance of guarantee labels by any agency involves the necessity for the most competent legal service obtainable. Enforcement of standard requirements must be prompt and adequate. Label-users must be vigorously protected against fraudulent use of the standard guarantee. In addition to issuance of labels, and legal services which assure and sustain the good-will value of the standards guarantee, an educational campaign must be conducted to promote and extend the benefits of standardization. After careful consideration of the cost of maintaining all these and further activities in line with our objects, our Board of Trustees authorizes me to state that National Standards Council is fully prepared and equipped to furnish all services essential to the certified-label program of any manufacturing group, without appreciable burden of expense comparable to the benefits to be gained. Such expense is met by payments made for labels, thus pro-rating the cost to each individual manufacturer in direct ratio to his production and sales;

4—To insure complete impartiality in respect to the various standards for which National Standards Council may issue its certification labels, we shall not establish or promulgate such standards;

5—Any industry which has developed a basis for standardization and is prepared to establish and promulgate a standard worthy of consumer-acceptance, is free to call upon National Standards Council for advisory or active assistance.

[1] The members of the Board of Trustees are: Albert F. Allison, New York City; Julia K. Jaffray, New York City; Leverett S. Lyon, Washington, D. C.; Colonel Joseph I. McMullen, Washington, D. C.; Harry H. Seemmes, Washington, D. C. Mr. Allison, who is secretary of the International Association of Garment Mamufacturers, 395 Broadway, New York City, is president of the National Standards Council.

Our Board of Trustees offers these conclusions for your consideration, assured that in our service plan there exists no possibility of misunderstanding or exploitation. Logic, reason, and sustaining evidence justify our belief that standardization, with its resultant benefits to manufacturer, distributor, and consumer, can best be made effective if impartially administered.

Variations in Drawing Sizes Cause Difficulties in Cutting and Filing

Drawing office executives will be interested in referring to an article by E. L. Chevraux, supervisor, Engineering Record Division of the Studebaker Corporation, in ***Machine Design*** for October, 1930. This article, entitled "Good Filing Equipment Saves Time and Money," includes much advice on the selection and design of files for drawings and material of similar physical form which will be of interest to those having to specify drawing office equipment. The author closes the discussion of his subject with a reference to the great difficulty met in filing cabinet design and selection by the variation in sizes of drawings adopted as "standard" by different companies.

"In fact," he says, "it is common for variations in this respect to exist between two or more drafting departments in the same organization. At least one of the larger drafting room supply houses is campaigning the adoption of some standard size which will effect the greatest saving in cutting sheets of bond paper, vellum, tracing cloth, etc., from roll stock of standard widths. As rolls of blue-print and vandyke papers are marketed in these same widths, it is suggested that a saving in waste may be made in reproduction work also. The prevailing trend, wherever changes are made or new standards adopted, is toward $8^1/_2 \times 11$ inches. The larger sheets run in multiples of this size, with a slight decrease in the large sheets to allow for folding blueprints to this base size, which is identical with the universally standard letter head. Standardization in this matter will tend eventually to bring about concentration on a lesser number of sizes and types of filing cabinets, thus encouraging improvements and attendant decrease in cost through the stimulation of wider competition on a standardized product."

Standardization Important Factor in German Industries

In an article under the heading "Germans are Cold to Ford Theories" by Kendall Foss in the *New York Times*, October 26, the following appears:

"The German is happy if he has found the way; by nature he is not especially interested in turning out thousands of duplicates of his invention. He does not exhibit much aptitude for standardization and seems to rebel against what he understands to be one of the outstanding characteristics of American life. The dozens of political parties in Germany and the rather dismal failure of correspondence school courses to become popular trace to the same national characteristic. Mail order houses have not really been tried, no doubt wisely."

Mr. Foss evidently is unaware that, in the field of industrial standardization, the Germans are second only to Soviet Russia in their interest in, and support of a national scheme of industrial standardization.

Meaning of Standardization Confused

Mr. Foss is undoubtedly making the same mistake that many other popular writers do in confusing mass-mindedness of a population with conscious standardization for the sake of industrial economy. The German is "by nature" (to use Mr. Foss' phrase) interested in turning out thousands of duplicates of his product in the same degree and for the same reason that an American mass-production manufacturer is, i.e., to increase the consumption and sale of his product and the profits which accrue to him thereby. He is equally interested "by nature," as are Americans, in developing new inventions; and the intelligent leadership of his standardization movement knows quite well that the mental qualities for carrying on industrial research and development, and what is more important the financial means to do so, will thrive best in a country where business men recognize the commercial economy of mass production of standardized goods and materials.

The *Times* correspondent is quite right in directing attention to the exceedingly active scientific and industrial development work going on in Germany at present, which may be a factor of the greatest importance to countries in world competition, but that is no justification in theory or in the actual practice of the German nation for the author's supposition that such activity excludes the application of common sense via standards and specifications in the field of industrial production.

Company Standardization as Developed by the Siemens-Schuckert Works at Vienna

by

F. J. Schlink, *Assistant Secretary*
American Standards Association

The Standards Bureau of the Siemens-Schuckert works in Vienna, Austria, is believed to be one of the best organized and most effective standards departments in any industrial company. This department is in close relation to the main office of the company in Berlin, with which a detailed interchange of material is carried on continually.

In general it uses, in addition to its own standards, the national standards approved by the "Oesterreichescher Normenausschuss für Industrie und Gewerbe" (Austrian Industrial and Trade Standards Committee). When no Austrian national standard is directly applicable, a German standard which is applicable may be employed. Some of the standards developed for the company's own specific purposes, which were noted as carrying out the principle of the "one best way" in manufacturing, and in plant and office operation, were mail-boxes for special delivery factory mail; name-plates for office doors; bases for inkwells; cases for gages; standard methods for attaching name-plates and rating plates to machines; standard practices for the welding of seams; standard practices for the calculation of springs, a very elaborate and comprehensive codification of the best-known practices in such work; ring or eye bolts and methods of testing them; perforated metal plates for use in floors, etc., six standard types being established; and standard corrugation for the surface of insulators.

As an illustration of the frequently cited reduction of unnecessary sizes and types through the organization of company standardization work, it was mentioned that a reduction of 49 per cent had been produced in the number of types of bolts, screws, and rivets used, which were decreased from 3149 to 1604, a saving of $110,000 in one year on screws and rivets alone. One of the most successful developments in standardization of work-shop appliances has been the design of a standardized tool cabinet and bench which is located at each lathe or other principal machine tool, and has brought about important direct and indirect savings in time and better utilization of equipment, as well as greatly improving the convenience of the work for the workmen themselves. Another valuable standardized appliance is a carefully planned tool chest for traveling repair and adjustment men. Three hundred of these have been made, providing standardized equipment in a carefully worked out arrangement. Improvement of conditions through mechanical standardization work, and reduction of numbers of types and sizes may be judged from the fact that 65 types of milling machines with 38 spindle noses were modified so that four spindle noses resulted. There were 199 different taper gages required in the work of the plant in which 118 different tapers (angles) were used. Now a total of but 90 gages, having 13 angles, is required. In rounds, flats, and other metal stock, a saving of 25 per cent resulted through systematic standardization. In milling cutter arbors, 547 different types and sizes, with 32 diameters and 31 tapers, were reduced to 203 types and sizes, with six diameters and four tapers.

The Siemens-Schuckert Works have prepared a reproduction of a chart and table which gives all of the cylindrical fits required in their machine production, reduced to a card $6\frac{5}{8} \times 4\frac{1}{2}$ inches. Both basic hole and basic shaft systems are shown, with four grades of fit. A copy of this, which may be suggestive to American firms of how their own or the ASA fit systems could be shown in graphic and condensed form, is available for loan to any organization which may be interested.

Every drafting office in the works, which employs a total of approximately 3200 men in five factories of which the two principal ones are in Vienna, has its own inspector.

It is his duty to examine each new drawing and design in respect to its use of company standards, when such standards are involved or should have been applied, and the correctness of its reference to and inclusion of nomenclature and dimensions of standard items. In this way failure to use standard materials, components, etc., or their incorrect use, is detected before the design reaches the shop.

Special parts, and material of non-standard qualities, are not procured by the purchasing department unless O. K.'d by the director of the standards department. The standards department of this works reports directly to the central

management controlling the several factories of the firm, and is parallel to the purchasing department in rank or position in the organization. Liaison with the other factories is usually through an engineer of managerial rank.

The standards bureau of the one works here discussed has twelve people on its staff, and includes among its duties the control of tools and gages, the necessary fine measurements required to be made in the control of production and inspection and, besides, the subject of accident prevention.

An interesting feature of the safety work is the photographic portrayal of accidents and accident hazards. When desirable to do so, the whole scene of the accident is posed and the occurrence re-enacted so that the photograph may show exactly what combination of errors brought about the difficulty; the names of the actors therein are given. These photographs, which are freely used in the education of the workmen, give a very much clearer picture of the occurrence than any other method could. Inspection of the plant for the condition of safety appliances and precautions is made each month.

A comprehensive system for the color marking of bars of steel used in the works is in service, but the company's expert holds the opinion that a complete national system for such a purpose is not feasible.

In some respects it is necessary to deviate from the German standards (which are followed to a considerable degree in the Austrian standardization work) on account of quality differences determined by the local source of supply. Thus, for example, there are special Siemens-Schuckert standards for the Vienna works for charcoal iron, piano wire, and tinned iron wire.

Specifications for such materials are written after contact with the suppliers for advice and samples and criticism of drafts, in the usual way. One standard, that for red fiber (Presspahn), is an unusual development in that it is a joint standard of the Siemens-Schuckert Works (SSW) in Berlin and the Allgemeine Elektriziatäts Gesellschaft (AEG). This arrangement, providing a joint basis for procurement of this important production item, has been found satisfactory to both suppliers and purchasers.

The methods of testing the accuracy of machine tools, as worked out by Dr. Georg Schlesinger, have been found most valuable. It is felt that these, while excellent and extremely useful in their present form, need some slight further development in factory testing practice and perhaps some further investigation of practical requirements in the use of machine tools. It is hoped that these methods will later become a national standard.

Many specifications are in use for the purchase of materials but are not yet formally adopted as works standards. Thus, there is such a purchase specification for spring sheet bronze. These purchase specifications are regarded as tentative and in a stage of evolution toward the definitive factory specification.

Each standard used in the works shows its relation to its corporate or Austrian national prototype. A standard which is adopted from the Austrian national standards is so designated on the sheet (Onorm) and likewise with the German (Dinorm) standards. All changes made in standards are carried out by the standards department itself on the works copy of the standard, and a minute card record is kept of all such alterations, a necessary precaution in view of the difficulty that would arise in case inconsistency in practice should develop through failure of any given department to be properly notified of changes in or elaboration of an important standard, design, or specification.

Important Paper on Lubrication and Lubricants

Those interested in the development of specifications for lubricants may wish to refer to a reprint, of which the ASA has a copy, of the paper "Some Contributions to the Theory and Practice of Lubrication" by J. E. Southcombe, M.Sc. (read before the North East Coast Institution of Engineers and Shipbuilders in Newcastle-upon-Tyne, England, on the 10th of February, 1928). The paper, which with its discussion extends to 22 pages, treats a number of rather modern considerations in respect to the molecular properties of the bearing surfaces and the mechanism of the formation of adsorbed films at the solid interface. A point of special interest is the treatment of the disturbing action of steam and water vapor on the oil film, considered from the physico-chemical standpoint.

New Committee Member

Eliot W. Niles of the American Telephone and Telegraph Company, New York City, has been appointed member-at-large on the sectional committee on standardization of plain and lock washers (B27). The American Telephone and Telegraph Company has a special interest in the work of the committee with a view to eliminating the general production of washers of such sizes that they might be used in coin-operated slot machines.

Mr. Niles has been assigned to the sub-committee on plain washers.

ASA PROJECTS

A Review of Mining Projects under ASA Procedure

The third of a series of reviews of standardization projects under the procedure of the American Standards Association

A review of all mining projects completed or in process of development under ASA procedure is given below. This is the third of a series of such reviews which are being published in the ASA Bulletin. The information is corrected to January 1, 1931. The personnels of the sectional committees handling the projects may be found by reference to the 1930 American Standards Year Book, pages 68 to 71, under the heading "Mining" (M).

M2-1926—Electrical Equipment in Coal Mines, Safety Rules for Installing and Using

Chairman—O. P. Hood, Bureau of Mines, Department of Commerce, Washington, D. C.

Safety in coal mines in the installation and use of electrical equipment is covered by rules, prepared by a technical committee under the joint sponsorship of the American Mining Congress and the U. S. Bureau of Mines, which were approved by the ASA as American Standard in 1926. This followed several years' work on the part of the sponsors, and successive earlier editions of safety provisions issued by the U. S. Bureau of Mines. In the preparation of the safety rules several definite aims were borne in mind: the removal of contributory causes of accidents or danger; separation of electrical apparatus from elements susceptible to its influence; restriction of the area of activity of electric current by protective devices where necessary; control of operation of electrically driven machines; and the provision of a large factor of safety in the selection, installation, and inspection of equipment. Specific references are made to the National Electrical Code (C1) and the National Electrical Safety Code (C2).

While Section 1 covers general requirements, voltage, rating, and capacity, and the prevention of accidents and fires, the second section deals specifically with such matters as equipment on tipples and surface structures, ventilating fans, hoists, underground stations and switchboards, and stationary lamps. Portable electrical equipment is covered in Section 3 and circuits and conductors in Section 4.

Following the publication of supplementary material by the U. S. Bureau of Mines early in 1930, the question of revision of the standard was considered by the sponsors and the committee in charge. The inquiry showed that the standard was in excellent shape, and that it would not be necessary to undertake revision until further experience or developments in the industry should make it desirable.

M5—Screen Testing of Ores, Methods for

Proprietary Sponsor—American Institute of Mining and Metallurgical Engineers.

Chairman—G. H. Clevenger, Chairman, Milling Committee, American Institute of Mining and Metallurgical Engineers, Boston, Massachusetts.

Early in 1930 a draft standard covering methods for screen testing of ores was submitted by the American Institute of Mining and Metallurgical Engineers. The first study of the subject, published in 1923, had been made on behalf of the Milling Committee of the American Institute of Mining and Metallurgical Engineers by Professor E. A. Hersam of the University of California, and had been continued by John Gross of the U. S. Bureau of Mines. Both reports have been given wide circulation, and since completing his study, Mr. Gross has been engaged in work entailing the making of many sizing tests, which afforded opportunity for a final check upon the procedure proposed.

Following a meeting of the Milling Committee of the American Institute of Mining and Metallurgical Engineers in February, 1930, a small committee was entrusted with the task of arranging in final form the draft standard, which was substantially the same as that already circulated, except that the supporting data had been eliminated. Standard scales were not included, but the sizes of the openings in screens were given.

The chairman of the committee subsequently

submitted the final draft to letter ballot of the Milling Committee, and for endorsement of the standard, to the chief manufacturers of screens. Since the Milling Committee consists of 58 members scattered throughout the United States, and also includes members in Australia, Canada, Mexico, and South Africa, some time must necessarily elapse before definite action by the committee can be expected, thus clearing the way for formal approval of the draft by the ASA.

M6-1927—Drainage of Coal Mines, Recommended Practice for

Scope—Standardization of practice in the use of field pumps, permanent pumps, piping for pumps, operation of pumps, storage of mine water, natural drainage, unwatering of abandoned workings and recommendations of metals and alloys with acid-resisting qualities.

Chairman—W. E. Housman, Research Engineer, H. C. Frick Company, Scottdale, Pa.

Secretary—J. M. Hadley, American Mining Congress.

The recommendations now in force were approved as American Tentative Standard in 1927, and were formulated by a representative technical committee under the leadership of the American Mining Congress. They were developed from work originally done in the field by the American Mining Congress.

Soon after approval in 1927 it appeared that an expansion and rearrangement of the material would be desirable. Accordingly the technical committee was enlarged and began work on a revision, with the above scope. The committee completed its revision and submitted it to the ASA for approval in August, 1930. Formal action has been delayed upon request of the National Electrical Manufacturers Association, which suggested a number of changes, some of which have been worked out and agreed upon, while other clauses, containing provisions which the operating group feel will facilitate the use of the standard in contracts, are still under consideration.

M7a-1927—Coal Mine Tracks, Signals, and Switches

Scope—Standardization of coal mine tracks and signals, including switches, wood and metal ties, and other items of track construction, together with recommendations of efficient installation and maintenance practices.

Chairman—F. C. Hohn, Superintendent of Transportation, Pine Hill Coal Company, Minersville, Pa.

Secretary—J. M. Hadley, Secretary, Standardization Division, American Mining Congress, Washington, D. C.

A comprehensive standard covering underground transportation in coal mines was originally planned, the first section of which, worked out under the leadership of the American Mining Congress, covered frogs, switches, and turnouts. This was formally approved as American Tentative Standard in 1927, under the title of Recommended Practice for Coal Mine Tracks, Signals, and Switches (M7a). Following a decision to handle other sections of the original project as separate projects (see M21, M25), about a year ago the technical committee in charge of this standard was enlarged, making it more representative of all interests desiring participation, and a revision and expansion of the existing standard was begun. A meeting was held in May, 1930, at which sub-committee work was planned. A committee on frogs and switches was detailed to prepare turnout specifications based upon the new 5-inch heel spread, adopted at the meeting in May, 1930, for all weights of rail up to and including 70 pounds. Other committees proposed were on wood mine ties (already organized), steel mine ties, track construction and maintenance, etc. (not yet organized).

In a meeting held in Washington on December 5, 1930, a preliminary report of the detail committee on frogs, turnouts, and switches (Chairman: R. L. Ireland) was discussed and satisfactory progress made. It was expected that further data would be ready for submission in a meeting to be held in the spring in Cleveland.

M10-1928—Miscellaneous Outside Coal Handling Equipment, Recommended Practice for

Scope—Standard system of signals for hoisting and lowering; requirements for devices used in hauling men on inclines; requirements for devices used in hoisting and lowering men in shafts; practice in safety methods around the tipple; fire protection; and shafting, pedestals, and bearings

Chairman—W. R. Roberts, Roberts & Schaefer Company, Chicago, Illinois.

Secretary—J. M. Hadley, Secretary, Standardization Division, American Mining Congress, Washington, D. C.

This project represents results of several years' work on a standardization report of the American Mining Congress, the organization taking the leadership in the development of the national standard, which was completed by a technical committee composed of representatives of nine national organizations. In the course of the work, the scope originally planned was narrowed down to exclude wire ropes, ladders and stairs, and fire-hose couplings, which were made subjects for separate standards, and is now limited to various miscellaneous practices around shaft and tipple. Formal submission to the ASA and approval as American Tentative Standard followed in 1928.

M11-1927—Wire Rope for Mines, Specifications for and Recommended Practice in the Use of

Chairman—Henry Mace Payne, Consulting Engineer, American Mining Congress, Washington, D. C.

Secretary—J. M. Hadley, Secretary, Standardization Division, American Mining Congress, Washington, D. C.

The preparation of specifications for wire rope for mines was conducted under the leadership of the American Mining Congress by representatives of thirteen national organizations. Both general and detailed requirements are specified for plow steel and cast steel wire rope, and construction, material, diameter, and lay are specified for each of the standard sizes given. The standard also includes recommended practice in use at mines. Following three years' work of the technical committee in charge of the formulation of the standard, it was submitted to the ASA and formally approved as American Tentative Standard in 1927. No revision is contemplated at present. The specifications have recently been reprinted by the ASA in standard form.

M12-1928—Ladders and Stairs for Mines, Recommended Practice for the Construction and Maintenance of

Chairman—Andrews Allen, 21 Van Buren Street, Chicago, Ill.

Secretary—J. M. Hadley, American Mining Congress.

This project was initiated in 1924 under the leadership of the American Mining Congress, which had previously prepared a report on the subject. The standard gives specifications for the proper location and construction of mine ladder ways and gives recommendations for the location of electric and power lines, so that persons using the ladder ways will not come in contact with such lines. It is prescribed that mine ladders should be constructed in accordance with the provisions of the American Tentative Standard for Ladders (A14-1923, and now under revision). Detail specifications for the construction of mine stairs, such as angle of inclination, height of riser, width of tread, and handrails are also given.

M13-1925—Rock Dusting of Coal Mines

Chairman—Howard N. Eavenson, Union Trust Building, Pittsburgh, Pa.

The first of a series of nationally approved safety codes in the mining field—and undoubtedly the most important to date—is Recommended Practice for Rock Dusting of Coal Mines, which was completed in 1925 by a technical committee of representatives of eleven national organizations under the leadership of the American Institute of Mining and Metallurgical Engineers. Rock dusting of mines is a recently adopted method of making non-explosive the coal dust in coal producing mines other than anthracite. It is accomplished by the dilution of the explosive coal dust with finely pulverized inert material, a percentage of 55 of incombustible material at least being called for. To insure safety every portion of a mine must be thoroughly and constantly rock dusted, which may be accomplished at a cost of less than one cent per ton of coal. The standard covers materials for rock dusting and their preparation, methods of applying the dust, and methods of inspection and renewal.

M14-1930—Explosives in Bituminous Coal Mines, Use of

Chairman—J. W. Paul, Bureau of Mines, 4800 Forbes Street, Pittsburgh, Pa.

Suitable types of explosives; their handling, storage, and transportation; and methods of use, with the necessary precautions for charging, and firing, form the substance of an important recent addition to safety codes in the mining field formulated under the auspices of the ASA. The Mine Inspectors' Institute of America took the leadership in the development of the specifications, with eight other national organizations. On completion in the spring of 1930, the document was formally approved as American Recommended Practice and issued in standard form by the ASA.

The value to the mining industry of the provisions contained in this pamphlet appears to be generally recognized. Calls for copies have been received from all the more important State Departments of Mines, which are giving it wide distribution among their bituminous mine inspectors.

M15—Coal Mine Transportation, Safety Code for

Chairman—Fred Norman, Chief Engineer, Allegheny River Mfg. Company, Kittanning, Pa.

Secretary—J. M. Hadley, American Mining Congress.

This project, which is to provide safety measures for mine transportation both under and above ground, was initiated in 1924, under the leadership of the American Mining Congress. A technical committee of representatives of eleven national organizations was formally approved by the ASA in 1925. Four successive drafts have been prepared, the last of which was considered by the committee which met in Washington early in December, 1930. The recommendations made have been circulated to the full membership of the committee for further study, and it is expected that a letter ballot of the completed draft code by the entire com-

mittee will follow in the near future. The draft covers transportation, underground and above ground at the mine, and haulage on slopes or inclines into mines; motor, animal, mechanical, and hand haulage; signals and provisions for safety in construction, tracks, cars, clearances, and loads; and operating rules.

M17-1930—Fire Fighting Equipment in Metal Mines

Chairman—Wm. Conibear, Safety Inspector, Cleveland-Cliffs Iron Company, Ishpeming, Mich.

Secretary—J. M. Hadley, American Mining Congress.

In October, 1930, provisions for fire fighting equipment in metal mines were formally approved as American Recommended Practice. They had been prepared by a technical committee consisting of representatives of eleven national organizations working for several years under the leadership of the American Mining Congress and the National Fire Protection Association. The standard provides measures to be taken for the prevention of fires; for fire fighting equipment; fire fighting personnel; and warning of fire through the circulation of a disagreeable odor through the mine over the air lines, or where electric equipment is available, through a definite series of flashes. Reference is also made to the national standards for fire-hose (L3-1929) and fire-hose couplings (B26-1925). A similar standard to cover coal mines is contemplated.

Copies of the standard, issued in standard form by the ASA, have been placed in the hands of the Safety Division of the U. S. Bureau of Mines, and have been distributed by state mining departments to their officials.

M18-1928—Underground Transportation in Metal Mines, Recommended Practice in

Chairman—George H. Rupp, General Manager, Mining Department, Colorado Fuel and Iron Company, Pueblo, Colorado.

Secretary—J. M. Hadley, Secretary, Standardization Division, American Mining Congress, Washington, D. C.

Since transportation problems in coal and metal mines differ in important ways, separate standards on the subject are in course of preparation. The document dealing with underground transportation in metal mines, prepared under the leadership of the American Mining Congress, was approved as American Tentative Standard in 1928. Among the provisions of the standard are the establishment of 18 in. and 30 in. as the standard gages of track for hand and for motor operation, respectively, and with 16 lb and 50 lb weights of rail, respectively; and a 0.5 per cent limit set for the grade of tracks.

It is proposed to enlarge the standard by the inclusion of additional features, for which an enlargement of the original technical committee will be necessary.

M19-1928—Mechanical Loading Underground in Metal Mines

Chairman—Lucien Eaton, 17 Battery Place, New York City.

Secretary—J. M. Hadley, American Mining Congress.

General requirements for mechanical shovellers and scrapers for use in metal mines, with recommended practices for their operation, form the subject of this standard. It was intended to indicate the general lines along which development might proceed. The present document was submitted by the American Mining Congress, and approved as American Recommended Practice in 1928, following two years' work of the technical committee. Plans are under way for revision and expansion of the standard.

M20—Classification of Coal

Chairman—A. C. Fieldner, Chief Engineer, Experiment Stations Division, U. S. Bureau of Mines, Washington, D. C.

Secretary—C. B. Huntress, Executive Secretary, National Coal Association, Washington, D. C.

To place the purchase and utilization of coal on a scientific basis is the proposed aim of a project that was initiated in 1927 under the leadership of the American Society for Testing Materials. The plan is to cover all coals, their classification to be based on such chemical and physical characteristics as will make the plan most readily adaptable to industrial and commercial use on a national scale. Emphasis has been particularly laid on the fact that the undertaking is to develop a useful and practical system, or systems, by means of scientific methods, and not to provide a classification that is suitable for scientists only.

The subject is, in the first place, being studied broadly under three divisions: scientific classification, use classification, and marketing practice. To provide further data needed, three small detail committees are also preparing reports regarding the origin and composition of coal and methods of analysis; the nature, location, and mode of occurrence of types of American coals; and a comparison of proposed and used classifications of coals.

A report on the many phases of the work under consideration will be found in ASA BULLETIN

53, September, 1930. Experimental work connected with the slacking properties of coal; friability tests; investigation of air drying losses and moisture determination of low rank coals; and calculated ash correction as used in the unit coal calculation are some subjects of special study. One man is working full time in connection with present and proposed systems of coal classification. A number of detail reports have been published; ten alone relating to the nature, location, and mode of occurrence of types of American coals have been published by the A.I.M.E. and others on railroad fuel, steam coal, coal for gas and coke production, marketing practice, etc.

A broadly representative technical committee (consisting of 29 representatives of 21 interested national bodies) was organized and formally approved in 1927. Frequent meetings of technical and sub-committees have been held, and the work is progressing most favorably in view of the magnitude of the project. In all that has been done, close contact has been maintained with similar work under way in Canada. In addition to the work of detail committees, a considerable amount of further experimental work will be required before a formal report of the technical committee can be expected.

M21—Coal Mine Cars, Specifications for

This project is in its early stages. At an informal initial meeting recently held in Washington, D. C., the American Mining Congress, which is taking the leadership in its development, stated that there are over two hundred million dollars worth of mine cars in operation in the coal industry, manufactured in probably more wasteful variety than any other item of equipment used underground, due to the lack of standards on the subject.

The recommendation of the informal meeting was that the project go forward and that it cover details of mine car parts only, such as heights, wheels, bearings, bumpers, couplers, drawbars, etc., without any attempt to standardize cars as a whole. It is considered that such standards will effect important savings to both the manufacturer and to the mine operator.

M22—Mine Timbering

Work on a series of standard specifications on mine timbering, under the leadership of the American Mining Congress, was initiated in the spring of 1930. A section dealing with the preservative treatment of coal and metal mine timbers was started immediately, and in November, 1930, a draft was completed, which it was expected would shortly be submitted for formal approval as a national standard. Other parts of the subject will follow. Five such sections have so far been planned. Specifications for grades, names, and sizes of both coal and metal mine timbers will be developed; as well as recommended practice for the use of timbers in coal and metal mines, and the storage of timbers.

M24—Electrical Equipment in Metal Mines, Safety Rules for Installing and Using

Chairman—F. L. Stone, General Electric Company, Schenectady, N. Y.

Secretary—J. M. Hadley, American Mining Congress.

In 1926 Safety Rules for Installing and Using Electrical Equipment in Coal Mines were formally approved as American Standard. Application of similar rules to metal mines has been the subject of recent study, and late in 1929 a draft report was completed and rather widely circulated for comment and criticism. In the meantime a representative technical committee had been organized and a meeting was held early in December, 1930, in Washington, D. C., at which the comments and suggestions received were considered in detail. Many changes were made in the report as a result of the meeting, and it is believed that the draft, with these changes inserted, will constitute a final report satisfactory to all and suitable for approval by the ASA.

M25—Trolley, Storage Battery, and Combination Type Locomotives for Coal Mines, Specifications for

Proposed Scope—(*a*) Design and details of locomotive construction; (*b*) Application of locomotives and conditions influencing application; (*c*) Control apparatus for electric mine locomotives, consisting of definition, classification, rating, and methods of test.

This project was initiated in 1929, the American Mining Congress and the National Electrical Manufacturers Association being designated as sponsors.

Early in 1930, the project C49-Electric Mine Locomotive Control Apparatus was combined with this project, the title remaining as given above, and with the American Institute of Electrical Engineers, the National Electrical Manufacturers Association and the American Mining Congress serving as joint sponsors.

The sponsors plan to organize the sectional committee in the near future. The American Mining Congress has appointed a small sub-committee to prepare material for submission to the sectional committee, and also expects that the members of this sub-committee will become members of the sectional committee.

Standards Council Authorizes Work on Leather Belting

The development of American Standard Specifications for Leather Belting (B42) by the sectional committee method under the sole sponsorship of the American Society of Mechanical Engineers was formally approved by the Standards Council at its meeting on December 11, 1930. Upon organization of the sectional committee, its activity will include the preparation of specifications for vegetable tanned leather belting, including raw material, construction, marking, physical and chemical tests.

The need for such a national standardizing activity was pointed out by the American Society of Mechanical Engineers July 13, 1928, and attention was called at that time to the several existing specifications on the subject. A preliminary conference and investigation indicated that none of the present specifications for the product was acceptable to industry as a national standard and also indicated the necessity of a meeting of representatives of a large number of technical societies and trade associations interested in the subject. This conference was held on February 6, 1930. At that time undesirable features of a number of the existing specifications were pointed out.

It was stated that the quality of any leather belt depended largely upon the character of the leather used in its construction. The selection of suitable sections from hides for use in belt construction depends almost entirely upon personal experience and mature judgment, which cannot easily be translated into terms readily understood by a novice. Several large users of leather belting, among which are the United States Steel Corporation, and the New York Central, and Norfolk & Western Railroads, supplement their belting specifications by maintaining resident inspectors in the plant of the manufacturer. This practice, however, was considered too costly to be followed by the average purchaser. Attention was called to the fact that the maintenance of a resident inspector by the United States Navy Department had been discontinued with the adoption of Federal Specification 37 for Leather Belting. The practice of the American Petroleum Institute, permitting the use of the A.P.I. monogram on belting supplied by manufacturers when guaranteed to be in accord with A.P.I. specifications, was also mentioned. The opinion was expressed that both of these groups were receiving a satisfactory product.

Later discussions of the subject by members of a special conference committee revealed the fact that belting manufactured from vegetable tanned leather comprised approximately 90 per cent of the belting produced, the remaining 10 per cent being made from leather prepared by a "mineral" or a combination "mineral-vegetable" tanning process. For this reason it has been decided to undertake first the development of specifications for vegetable tanned leather belting, although leather prepared by the other two tanning processes may eventually be given consideration by the sectional committee.

Rotating Electrical Machinery Projects Consolidated

At the meeting of the Standards Council held on December 11, 1930, consolidation of the project on synchronous converters (C21-1926) with that on rotating electrical machinery (C50) under the title Rotating Electrical Machinery (C50), for which the American Institute of Electrical Engineers and the National Electrical Manufacturers Association are joint sponsors, was approved. This consolidation was made upon the request of the American Institute of Electrical Engineers, sole sponsor for the project on synchronous converters, and is in line with the movement for producing a large number of standards for rotating electrical machinery in one sectional committee to insure that all standards approved will be uniform in all essential respects. The project on rotating electrical machinery was formed from four separate projects covering direct current, alternating current, and induction rotating machinery, and fractional horsepower motors.

The sectional committee on rotating machinery has progressed rapidly on that part of its work which covers efficiency and losses, and in anticipation of the addition of synchronous converters to its work, included this subject with the others covered by the report on efficiency and losses.

A. A. Stevenson Represents ASA on Planning Committee

The re-appointment of A. A. Stevenson, past-president of the American Standards Association, to be the Association's representative on the Planning Committee of the Division of Simplified Practice for the year 1931 was announced at the December 11 meeting of the ASA Board of Directors. It was announced at the same time that Mr. Stevenson had been elected to the chairmanship of the Planning Committee.

Allowances and Tolerances for Cylindrical Parts and Limit Gages

A reorganization meeting of the ASA technical committee on Allowances and Tolerances for Cylindrical Parts and Limit Gages (previously designated as Plain Limit Gages for General Engineering Work) was held on December 5, 1930. The original committee was appointed in 1920 under ASA procedure and sponsored by the American Society of Mechanical Engineers, the reorganization taking place under the same auspices.

The meeting was conducted by the chairman of the new committee, Edward J. Kearney, secretary-treasurer of the Kearney-Trecker Corporation, Milwaukee, Wisconsin. More than sixty industrial organizations believed to be interested in the project had been invited by the ASME to appoint representatives on the technical committee. Suggestions were made during the meeting for further members to be invited to accept appointment as members-at-large. The list of personnel will be published as soon as completed. The committee appointed C. E. Rundorff, Research Department, Buick Motor Car Company, as secretary.

After Mr. Kearney had spoken a word of welcome to the new committee, John Gaillard, Mechanical Engineer of the ASA, submitted a statement covering the work of the original committee and the attitude which American industry had taken with regard to the results of this work. A standard on Tolerances, Allowances, and Gages for Metal Fits had been established by the original committee and approved as an American Tentative Standard by the ASA in 1925. It had not been widely adopted in practice, a fact probably due to three principal circumstances. First, the use of a system of tolerances was still much neglected in cases where it could be applied with advantage. Second, some concerns had a system of tolerances of their own at the time the American Tentative Standard was approved. In such cases, transition to the new standard would evidently require some time. Third, objections had been raised against the American Standard on various grounds. One of these concerned the fact that present sizes of commercial stock reamers could not be used economically for producing the holes specified by the standard, due to the circumstance that they were made with a small plus tolerance on nominal size. If made between two limits lying a certain distance above the nominal size they would be suitable for finishing, first, standard holes with the coarsest tolerance and, subsequently, standard holes with smaller tolerances. In this way maximum wear life would be obtained from the reamers. However, as no change was made in the manufacturing limits of commercial stock reamers after the American Standard on Fits had been approved, some firms were hesitant about adopting the latter with a view to the practical necessity, in case of such adoption, of using reamers considered as "special" by the tool manufacturers.

David Ovaitt, chairman of the Tool Standards Sub-Committee, General Motors Corporation, who was present at the meeting as a member of the new ASA committee, explained the reasons which had led General Motors to adopt its special system of hole tolerances and the reasons why no shaft tolerances have been standardized by his company. With regard to the discussion that followed this explanation, reference may be made to Mr. Ovaitt's articles "Tolerances and Tools" published in *American Machinist*, June 5 and 12, 1930, and Mr. Gaillard's discussion of those articles in *American Machinist*, November 6, 1930.

Standard Restricts Choice

With regard to the other essential features of the American standard system, the attitude of industry had been as follows, Mr. Gaillard said. The reference temperature of 68° for limit gages had been generally adopted. The fact that the American Standard gives only a basic hole system had been criticized by concerns which could use with advantage bar stock that was supplied by the mills in cold-finished or ground condition and therefore did not require a machine finish in the shop. The eight fits specified in the American Standard had proved to give the designer too restricted a choice, even though the standard holes and shafts could be cross combined. For example, a class 2 hole may be mated with a class 3 shaft. Also, some firms who had adopted the standard fits had reduced the number of steps into which the range of nominal diameters up to $8^1/_2$ inches had been subdivided, a simplification which could be made without any difficulty. Some users of the standard had complained about a lack of clarity of the tables of allowances and tolerances, a point of minor importance with regard to the technical merits of the standard, but of sufficient practical importance to warrant some attention in revision.

Summarizing, the speaker therefore recommended to the committee that consideration be

given to the following points: the inclusion in the standard of a basic shaft system in addition to the basic hole; an increase in the number of standard fits; a reduction of the number of steps in the range of nominal diameters given in the tables; and possibly a rearrangement of the presentation of the numerical data. Moreover, the reamer problem would evidently call for thorough discussion.

Only editorial changes were made by the new committee in the scope of the work as adopted by the original committee, the revised wording being as follows:

"Nomenclature and classification of fits between cylindrical parts, including allowances and tolerances for interchangeable manufacture; classification and fixing of standard tolerances for plain limit gages."

The title of the project was changed to Allowances and Tolerances for Cylindrical Parts and Limit Gages.

Sub-Committees to Be Appointed

The members of the committee agreed that their work would call for the appointment of several sub-committees and decided to leave this to the chairman, Mr. Kearney, with power.

The attention of the new committee was also drawn to the efforts that are being made to arrive at international unification of standard fits. Mr. Gaillard reported on the work undertaken by a technical committee under the auspices of the International Standards Association (ISA) of which the ASA is a member. A sub-committee of five delegates of national standardizing bodies (Czechoslovakia, France, Germany, Sweden, and Switzerland) was developing a proposal to be submitted to all national standardizing bodies. (National standard systems of fits have been adopted so far in twelve countries, including the United States.) The ASA would bring the proposal to the attention of the committee as soon as it is received. In the meantime the committee was requested to decide whether or not it wished to cooperate in the ISA work. Mr. Gaillard said that formal cooperation would not commit the American committee to the acceptance of the results of the ISA work as a national standard. It would, however, present the advantage of giving more weight in the international discussion to the American attitude regarding this subject. Also, it would secure the American group a vote on the proposals worked out by the ISA committee. The new technical committee unanimously decided to cooperate with the ISA committee by giving consideration to the proposals the latter is now developing and by formulating such criticism and comment, or possible counter-proposals as might appear to be desirable.

Anyone interested in the details of the statement submitted to the meeting by Mr. Gaillard may obtain a copy from the ASA office.

New Officers of Safety Code Correlating Committee

The following new officers of the Safety Code Correlating Committee were announced at the annual meeting of the American Standards Association, December 11:

Dr. L. W. Hatch, Department of Labor, New York City, chairman

W. S. Paine, Aetna Life Insurance Company, Hartford, Connecticut, vice-chairman

Colonel J. P. Jackson, New York Edison Company, New York City, vice-chairman

The above officers, together with the following members, will constitute the executive committee of the Correlating Committee:

L. F. Adams, General Electric Company, Schenectady, New York

W. D. Keefer, National Safety Council, Chicago, Illinois

M. G. Lloyd, Bureau of Standards, Washington, D. C.

The secretary of the committee is P. G. Agnew, secretary of the American Standards Association.

Woodruff Keys Standard Approved by ASA

The American Standards Association has approved as an American Standard the dimensions for Woodruff keys, keyslots, and cutters (B17f), submitted by the American Society of Mechanical Engineers as sole sponsor for the sectional committee on Standardization of Shafting.

This new American Standard was given considerable publicity during the early stages of its development (see page 27, November, 1930, issue of the ASA BULLETIN) and has been found to meet the desires of the industry.

The standard is being published in pamphlet form by the American Society of Mechanical Engineers, and copies may now be ordered.

ASTM Requests Standardization Project on Sieves for Testing Purposes

The American Standards Association has been requested by the American Society for Testing Materials (ASTM) to authorize the organization of a technical committee to set up standard specifications for sieves for testing purposes. Specifications for such sieves were developed by the ASTM in cooperation with the Bureau of Standards and adopted by the ASTM in 1926. These specifications agree in essential requirements with the series of standard sieves established by the Bureau of Standards. The ASTM specifications will be offered as a working basis for the ASA technical committee if the latter is appointed. The ASTM and the Bureau of Standards are willing to act as joint sponsors for the new project.

In addition to being of national interest, the above request is also important with regard to international developments in this field. A technical committee was appointed under the auspices of the International Standards Association (ISA)—of which body the ASA is a member—and work on the subject of testing sieves was taken up some time ago, the international secretariat being entrusted to the Polish national standardizing body. The ASA has informally cooperated in this work by supplying the ISA technical committee on sieves with information regarding the situation in the United States. If an ASA technical committee on sieves is appointed it seems probable that this committee will wish to cooperate in the international work.

Progress of the international work was discussed at a technical conference held under ISA auspices in Vienna in September, 1930. It was agreed on this occasion that testing sieves would be defined as sieves used for testing the material to be sifted, but not for testing the working sieves. Although the testing sieves and the working sieves are required to have the same width of mesh, the conference agreed that the wire diameter of a working sieve and the corresponding testing sieve need not be the same. It appeared that in Germany test sieves were frequently used as working sieves because of their greater accuracy, as the price of testing sieves is not very greatly above that of working sieves.

With regard to wire diameter it was proposed to investigate whether it would be possible within certain limits to use the same wire diameter for a number of consecutive sieve sizes.

The discussion resulted in agreement on the fact that the width of mesh should be considered as the basic feature of the sieve, and not the number of meshes per unit of length or area. In this connection the German delegate, Mr. Gramenz, made the following interesting statement with regard to experiments carried out in Germany to determine the influence of deviations of the actual width of the meshes from their nominal size:

> "The most important characteristic feature of sieve cloth is the width of mesh. For a given width of mesh, the wire diameter has no influence or only a very slight one, on the effect of the sieve. The unavoidable errors in the size of the meshes, however—usually designated as 'false meshes'—have important influence on the sieve performance. Comparative sifting tests have shown that a single false mesh showing a variation from the nominal size of 51 per cent reduced the oversize obtained during a ten minutes' sifting period, from 20 to about nine per cent. In other experiments where a sieve without 'false meshes' gave an oversize of 14 per cent, during a ten minutes' sifting period, this oversize was reduced to nine per cent by the presence of two false meshes with an error of 25 per cent; and to four per cent, by two false meshes with an error of 51 per cent. The sieve used in these experiments had a width of mesh of 1.35 mm. Another sieve with a width of mesh of 2.04 mm gave an oversize of about 3.5 per cent, during a ten minutes' sifting period. Therefore, the sieve with a width of mesh of 1.35 mm and two false meshes with an error of 51 per cent gave about the same result, during a ten minutes' sifting test, as a sieve with a width of mesh of 2.04 mm without false meshes."

Furthermore, it was agreed that the ratio between wire diameter and width of mesh was an important factor and should be given due consideration. For example, in the German standard this ratio is 2:3.

As the practical low limit of the width of mesh, the size of 40μ was proposed (1μ equals 0.001 mm or about 0.00004 inch), and as the maximum limit the value 25 mm. The Polish secretariat was asked to work out a proposal based on a geometric series of mesh widths.

The conference was of the opinion that the

time was not yet ripe for discussing the questions of tolerances on the width of mesh and on wire diameter.

A proposal of a series of standard testing sieves believed to be internationally acceptable will be submitted to all member-bodies of the ISA when it has been worked out by the Polish secretariat, and laid by the ASA before the ASA technical committee on sieves, if this be appointed. The American interests will then be asked to submit criticism and comments on the proposal and make such counter-proposals as they see fit, reflecting the attitude regarding the subject in the United States.

New Safety Code for Coal Pneumatic Cleaning Plants Approved

Another Safety Code for the Prevention of Dust Explosions was approved as American Standard on December 31, 1930. This code covers Coal Pneumatic Cleaning Plants (Z12f) and was developed by the sectional committee on Dust Explosion Hazards under the sponsorship of the United States Department of Agriculture and the National Fire Protection Association.

The code states, in a discussion of the types of systems, that

> "Coal pneumatic cleaning systems employ air pressure and evacuation and are subject to the hazards incident to the creation and distribution of dust, explosive in air when ignited. The two principal parts of the apparatus which create the dust and which also may be the means, unless properly designed and operated, of distributing dust are:
> "a. Screens, shaking and/or vibrating screens and revolving screens.
> "b. Pneumatic jigs or tables for separating the pure coal from the refuse."

The standard gives specifications for the construction of the building in which pneumatic screening and cleaning equipment and driers are located, the arrangement of the screen room and the rooms in which the pneumatic jigs or tables are located.

Detailed specifications for the ventilation of all parts of the building in which the process of coal pneumatic cleaning is carried on and specifications for methods of dust collection are also given.

Reference is made to the National Electrical Code in connection with electrical installations for light, heat, and power.

This code is the sixth of the series of codes developed by the Dust Explosion Hazards Committee. The other codes are:

Safety Code for the Installation of Pulverized Fuel Systems—Z12a-1930

Safety Code for Pulverizing Systems for Sugar and Cocoa—Z12b-1930

Safety Code for the Prevention of Dust Explosions in Starch Factories—Z12c-1927

Safety Code for the Prevention of Dust Explosions in Flour and Feed Mills—Z12d-1928

Safety Code for the Prevention of Dust Explosions in Terminal Grain Elevators—Z12e-1928

Foundry Equipment to Be Standardized

The initiation of a project for the standardization of foundry equipment was approved by the Standards Council at its meeting on December 11. The work will be undertaken by a technical committee to be appointed under ASA procedure and jointly sponsored by the American Foundrymen's Association and the American Society of Mechanical Engineers. The decision was made on recommendation of a special committee under the chairmanship of George L. Markland, Jr., of the Philadelphia Gear Works, Philadelphia, Pennsylvania.

Several months ago the American Foundrymen's Association and the American Society of Mechanical Engineers requested that a committee be organized to undertake this work. At that time, the American Foundrymen's Association suggested that this project might include the standardization of many types of foundry equipment.

Color markings of foundry patterns have already been standardized by the American Foundrymen's Association, and a report on this subject, published in 1926, has been widely used.

Two projects, under ASA procedure, concerning foundry practice have been under the leadership of the American Foundrymen's Association. These are the safety code for the protection of industrial workers in foundries (B8-1922) and the standards for outside dimensions of plumbago crucibles for non-tilting furnaces in nonferrous foundry practice (H13-1925).

Government Printing Office Is ASA Member-Body

The United States Government Printing Office, located in Washington, D. C., has just become a Member-Body of the American Standards Association. The Government Printing Office is the largest printing establishment in the world, being responsible for all of the printing of the United States Government. This includes not only congressional records and official documents but also technical papers and reports prepared as the result of research carried on by the various branches of the government. The Government Printing Office is not under any department of the government, but is directly responsible to Congress.

George H. Carter is Public Printer, in charge of the Government Printing Office. The technical director in charge of the research laboratory is B. L. Wehmhoff.

The standardization activities of the Printing Office have already resulted in savings of considerable magnitude to the government. Envelopes are now of four standard sizes, replacing nearly a dozen sizes formerly used. Nineteen standard blank books are now made in place of 375 varieties formerly purchased. This standardization of blank forms, according to the Report, "has effected much-needed uniformity in the transaction of government business, as well as materially reducing the cost of printing."

Among other standardization activities of the Printing Office is an effort now being made to simplify type faces used. Originally 107 type faces were in use, which number has now been reduced to 32.

Material purchased on standard specifications, which includes paper, envelopes, ink, type-metal alloys, rollers, and glues, are tested in the laboratory of the Bureau. Acceptance of paper, for instance, is determined by physical, microscopic, and chemical tests.

Research work is carried on constantly by the Printing Office; the investigations cover paper, type, metal, printing inks, bindery adhesives, detergents, lubricants, textiles, leathers, threads, and other printing and binding materials, as well as the study of air conditioning and other engineering problems of a printing plant. Special research on these materials has been done in cooperation with the Employing Bookbinders of America, and with the mechanical department of the American Newspaper Publishers. Tests of newsprint paper covering fiber content, thickness, ash, bursting strength, stretch, oil penetration, and ream basis weight have also been been made in cooperation with the latter organization. In order to determine printing qualities and resistance to ink penetration, many samples were also tested for gloss or finish and for porosity or air permeability.

The importance of such research to the technical progress of the printing industry as a whole was pointed out recently in an address before a meeting of the Master Printers of London by George H. Riddell, one of the outstanding English printers, when he said:

> "The craft of printing has been built up largely by rule of thumb methods . . . . Empirical methods are not sound under modern conditions. Those who supply the printer with his raw materials—the paper maker, ink maker, and type-metal manufacturer—are all rapidly introducing scientific control with their businesses and for this reason alone it would be advisable for the printer to meet them equipped with the necessary scientific knowledge to understand what is being done for him. It is only in this way that the printer will be able to demand the best materials and to make sure that he gets them."

The Public Printer, speaking before the World Conference on Printing Research held in Pittsburgh, November, 1929, said:

> "This leads me to suggest what I believe is the real necessity at this time for scientific research in the printing industry; that is, the standardization of materials required in printing, whether it is wasteful or useful, varied or uniform. In such standardization, organized scientific research can be of the greatest service to the printing industry."

Standard for Steel Shapes Approved by ASA

The American Tentative Standard Zinc Coatings on Structural Steel Shapes, Plates, and Bars and their Products (G8c-1930) has been approved by the Standards Council.

The standard was submitted for ASA approval under the proprietary sponsorship method by the American Society for Testing Materials. It includes designations of specific grades of structural steel, grades of galvanizing spelter bath, maximum amount of impurities allowed in the molten zinc bath, specifications for steel embrittlement, weight of zinc coating, and a test for uniformity of zinc coating.

A discussion of the standard appeared on page 33 of the December, 1930, issue of the ASA BULLETIN.

Some Conclusions concerning Maintenance of Industrial Standards[1]

by

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University of Pennsylvania

Maintenance of standards in plants is discussed as necessary part of scientific management

The utilization of the scientific method in the solution of business problems is relied upon by every modern manager. All pertinent facts with reference to the specific business situation under consideration are gathered, classified, and evaluated, and upon this study a decision is made, rather than upon mere guess or opinion. We live in an age where fact is rapidly supplanting opinion, where careful study, investigation, and research are replacing rule of thumb methods. In a business, therefore, which is in tune with this age of fact and research, standards must necessarily be developed because standards are the result of careful investigation and research.

A study of the works of Frederick W. Taylor will show the tremendous importance which he placed upon the establishment of standards, and even a casual study of the *Bulletin of the Taylor Society*, from the earliest days of its publication, will indicate that this basic management step has been among the subjects receiving most attention.[2] Further evidence of the emphasis placed by the Taylor Society upon the establishment of standards is seen in the book published under the auspices of the Society entitled "Scientific Management in American Industry," in which one of the major divisions deals with management standards. By establishing standards, one lays the foundation or base of modern management, and as a firm base or foundation is necessary for a safe superstructure, it is impossible to over-emphasize the importance of standards.

If it is true that standards form the base or foundation of modern management upon which the superstructure (control) is built, then it must also be true that if that base or foundation is not maintained but is permitted to waste away or disintegrate, the superstructure becomes unsafe and must eventually collapse. It is the recognition of this situation that led Taylor and his associates to recognize the fact that standards were only valuable as long as they really were standards and that their maintenance was quite as important as their original determination or establishment. As early as 1893 in a paper entitled "Notes on Belting,"[3] delivered before the American Society of Mechanical Engineers, Frederick W. Taylor had the following to say with reference to maintenance:

> "Serious repairs to belting, as well as to all other machinery in a mill, should be prevented as far as possible by systematic and careful inspection at regular intervals, and the writer has found a tickler, having a portfolio for every day in the year, from which reminders to inspect and examine are issued daily, an invaluable aid in caring for the machinery of an establishment. With this method, a belt should rarely slip or give out while in use, and most repairs can be made out of working hours."

In this paper Taylor not only established certain definite standards for belting, but he also immediately devised a method of maintaining these standards, an idea which should be kept in mind by all who are establishing management standards. Taylor always recognized the fact that the mere establishment of a standard was only a part of a task and that the complete task was not accomplished until he had perfected a method which would assure the maintenance of the standard which he had established. The fundamental principles of maintaining standards,

[1] Paper presented before a meeting of the Taylor Society, New York, December 4, 1930. Reprinted from the December issue of the *Bulletin of the Taylor Society*, by permission of the editors.

[2] See paper by H. K. Hathaway entitled "Standards," *Bulletin of Taylor Society*, Vol. XII, Nos. 5 and 6, October and December, 1927, pp. 491 and 540.

[3] Transactions of the American Society of Mechanical Engineers, Vol. XV, 1893, p. 7.

which Taylor set forth as early as 1893 are the principles which are used today in the plants of the country which have given maintenance of standards careful thought and study.

Although Taylor early had greatly emphasized the importance of the maintenance of standards, very little was done in this field of activity until quite recently, except in those plants in which he and his associates were working.

A real contribution to the literature on maintenance was made in May, 1917, when the Taylor Society published a paper by H. K. Hathaway entitled "Maintenance of Machinery and Equipment as Part of the Taylor System of Management." In this paper the method used by Taylor and his associates for maintaining standards of machinery and equipment was outlined and briefly explained.

Within recent years much more interest has been shown in the subject of maintenance of standards, but that interest can by no means as yet be called widespread, although there are a number of companies in the country which recognize maintenance of standards as an important problem and have well-developed methods of handling it.

The subject "maintenance of standards" is such a broad one that it will not be possible here to go into a detailed and exhaustive discussion of the maintenance of all possible standards, nor is it the purpose of this paper to give the detailed technique of the operation of every department responsible for maintaining a standard. The discussion will therefore be confined to the maintenance of standards of plant and equipment, tools, raw material, worked materials, finished product, and what has been called "plan of organization" and its mechanisms. It is proposed to discuss what might be called the fundamentals of the maintenance of each of the standards set forth above, and by examples to illustrate how some of these fundamentals have been successfully applied.

I

Maintenance of Standards of Plant and Equipment

Proper maintenance of plant and equipment has always been important, but it has only been within recent years that any considerable number of manufacturing establishments have given the problem the same careful thought and attention which they have been devoting to other management problems, even though proper maintenance was often an integral part of the problems for which they were attempting to find an adequate solution. There are many reasons which might be advanced to account for the increasing interest of the manufacturing community in the more effective handling of plant and equipment maintenance. It will be well to mention a few of these reasons at this point in order that some of the methods and details which will be described later in this paper may be better understood. Among these reasons are the following:

Increased mechanization
Greater investments in machinery and equipment
Greater emphasis upon working conditions
Greater emphasis upon quality
Greater use of incentives
Greater use of cost accounting and budgeting

Increased Mechanization

The rapidity with which industry is progressing at the present time in the direction of complete mechanization is remarkable. Many operations which only a few years ago were largely dependent upon individual workers both for quality and quantity of production are now to a great extent being performed by machines. Where production is dependent largely upon the performance of a machine, the importance of making certain that the machine will perform consistently in order to obtain high production is apparent. Moreover, the failure of a machine or other piece of equipment becomes much more serious under our present methods of production. The failure of a conveyor being used in connection with the assembly of a radio set or automobile does not merely result in the idleness of one worker but causes every worker along that line to be idle and will result in no work whatever being performed. The failure of a single machine under older methods of production merely resulted in the loss of production of one worker.

Greater Investments in Machinery and Equipment

Increased mechanization results in larger capital expenditures, so that now the amount of money invested in machinery and equipment in American factories is tremendous. Whether or not these investments will prove profitable will depend, among other things, upon whether or not the machinery can be kept in continuous operation. If this equipment is not kept in operation, there will be losses because of heavy fixed charges as well as from the very rapid rate of obsolescence of many types of modern machinery. Because of this high rate of obsolescence, many manufacturers insist that new equipment pay for itself in two years, and in some cases even in one year. If this is to be done this equipment cannot be permitted

to stand idle for any reason which it is possible to prevent.

Greater Emphasis upon Working Conditions

Another important reason for the present emphasis upon maintenance is the fact that American manufacturers are beginning to realize, as they never did before, the importance of good physical working conditions if both high production and high quality are to be obtained. Good lighting, a clean workshop, proper air conditions are factors which promote healthy shop conditions and directly result in greater production and higher quality of work.

Greater Emphasis upon Quality

In American industry, yearly, greater emphasis is being placed upon quality of product. In order to obtain quality from machines it is necessary that they do more than merely run well enough to obtain production. They must be so well maintained and adjusted that production of high quality from them is not only possible but certain. Thus again the maintenance of standards becomes of increasing importance.

Greater Use of Incentives

The importance of proper maintenance is emphasized when one considers it in connection with the utilization of incentive systems of wage payment. The failure to maintain standard conditions on a job, after the time study has been made and the rate set, has caused no end of hard feeling on the part of the workers toward the management, and the total failure of many an incentive system of wage payment which might otherwise have resulted in increased wages to the worker and increased profits to the management. It is unfair, for example, to set a rate on a machine when it is operating at a definitely pre-determined standard speed and then insist that that rate stand when, at some future time because of poor maintenance, the machine only operates at, say, 85 per cent or less of the standard speed.

Greater Use of Cost Accounting and Budgeting

Another reason that the maintenance of standards of plant and equipment is assuming a rôle of importance at the present time which it never assumed before is because two of the mechanisms of modern management—cost accounting and budgeting—have exposed the costliness of any program which does not provide adequately for proper maintenance. The great losses resulting from improper maintenance are exposed through properly developed factory cost accounting, and modern budgeting has brought forcefully to the attention of those in control the great sums which are spent for maintenance, emphasizing the necessity of having this work performed in a more scientific manner and at reduced cost.

2

Prevention

As was said before, there is relatively little which is really new in the present methods used in maintaining standards, and this is particularly true with reference to the maintenance of standards of plant and equipment.

The basic idea in back of all modern maintenance is prevention and, as has been pointed out before in this paper, Taylor as early as 1893 had written on this subject and even before that time was practicing preventive maintenance at the Midvale Steel Works in Philadelphia. In many organizations even at the present time, the responsibility for the condition of machinery, equipment, and buildings is left entirely to the superintendent or foreman. While a repair department may exist, it acts only upon orders of a superintendent or a department head. It does not take the initiative in maintaining equipment to any set standard. Consequently, machinery is often permitted to operate long after the time it has stopped producing economically, and, in many cases, so long that serious breakdowns occur and expensive repairs and long and costly production delays result. Often under these conditions as long as the machine is able to turn out some production, no matter how little, no action is taken to have it repaired or adjusted. The costliness of such a method, in terms of excessive repair cost and expensive production delays, is apparent, as well as the fact that such a method of repair of equipment is absolutely incompatible with scientific management, which is necessarily based on carefully developed standards. Under scientific management, the entire shop management is based upon the idea that every machine will operate under the greatest practicable load, and failure to maintain the machine in a condition which will make this possible immediately makes impossible the highest type of shop management.

The idea of preventive maintenance is worked out by centralizing the responsibility for the condition of machinery and equipment. Instead of having every foreman responsible for the condition of his machinery, a maintenance department takes over this responsibility and assumes the initiative in seeing that the established standards are maintained. This is done by means of regular scheduled inspections, through which difficulties are anticipated and the machines always kept in standard condition.

The attitude of the modern maintenance department is not to permit a considerable lowering of the established standard to occur and then by repair to bring the machine up to the standard, but rather to see that the machine is constantly operating up to standard and to remedy any conditions which may result in a lowering of the standard in the future.

If a system of preventive maintenance through inspection is to be practicable a few fundamental requirements must be met:

> Standards must be established for every piece of machinery and equipment and every machine should be placed in this standard condition. In order to maintain a standard, a standard must be first established. In bringing existing machinery and equipment up to a standard, sometimes complete overhauling is necessary and sometimes merely adjustment suffices. Some companies in which maintenance of plant and equipment has been well developed, in taking over other factories where no systematic maintenance was practiced, make it a rule to completely overhaul all machinery and equipment to be certain that it is placed in standard condition.
>
> A careful study should be made of the machinery and equipment in order to develop a schedule which will indicate the frequency of inspection of the various parts to be inspected. Obviously the possibility of failure of all parts is not equal. Some parts may require daily inspection, whereas for others monthly inspection may be adequate.

Table 1. Inspection Time-Table for Maintenance Equipment[4]

Item	*Period of Inspection*
Belting, leather-new belt	End of 24 hr.
	End of 48 hr.
	End of 1st week
	End of 1st month
	Thereafter every 2 months
Downspouts and flushing	During every storm
Drinking water system	Every day
Electric lamps	Every 6 months
Electric lamps (industry location)	Every 3 months
Fire escapes	Paint every 2 years
Fire pails	Every week
Hose	Test under pressure every year
Hose	Dry immediately after using
Insulation (steam or hot water pipes)	Every month for damages
Putty in sash	Every fall
Racks, store room	Every 6 months
Roofs	After every storm
Sash, steel	Paint every 3 years
Sash, wood	Paint every 3 years
Shafting	Every 6 months
Sprinkler equipment	Every week
Steel tanks	Paint every 3 years
Structural steel	Paint every 2 years
Tin roofs	Paint every 3 years
Toilets	Every day
Turbine, steam	Every year
Valves (heating system)	Every fall
Washbowls (office)	Twice every day
Washbowls (shop)	Every day

[4] Management's Handbook, page 1043.

After the schedule of inspection has been developed, a tickler file should be established which will automatically bring forth those items which are to be inspected on a particular day. This is a device which was used with great effectiveness from the earliest days. Individuals may forget, but a properly operated tickler never forgets.

The method of inspection should be carefully defined. The inspector should be told definitely the items to be inspected and instructed in the method to be followed and a written report should be obtained from him covering every item. If an inspector without detailed instructions is told to inspect a given machine it is very likely that he will overlook some important part. If he is told what to inspect and how to inspect, and is asked to report the condition of every item he checks, thorough inspection is assured. As a result of this inspection report, repair orders may be issued or the date of the next inspection may be determined if that date is to be sooner than the next regular inspection.

Best results with inspection have been obtained when the responsibility for inspection has been placed upon full time inspectors in plants, having sufficient work for such inspectors. Inspectors should be carefully chosen for their honesty and knowledge of the equipment involved, and should be instructed in inspection methods. The attitude that anyone will make a good inspector will lead quickly to the failure of the entire plan of preventive maintenance.

The inspector should make no repairs, although he may make minor adjustments in the course of his inspection. When inspection is added to the regular duties of other maintenance men, such as millwrights and electricians, it is very likely that it will be neglected as all routine duties will be performed before inspection, and inspection will be looked upon as a means of filling in time.

Should a failure of a machine or a piece of equipment occur in spite of regular inspections, a careful investigation of the cause should be made to determine why the failure was not anticipated by the inspection and thus prevented. It may be that as a result of this investigation a revision of the inspection schedule may be necessary.

It is well to bear in mind that regular inspection of machinery and equipment has a very favorable psychological effect upon the worker. If he knows that his machine is going to be inspected at regular intervals and that a report as to its conditions, use, abuse, and cleanliness will be made, he ordinarily will take greater care of it. This result has been noticed by a number of companies.

Regular inspections of the buildings proper, floors, lighting, piping, painting, roofs, etc., should be scheduled exactly as inspections of machines and equipment are scheduled. This portion of plant maintenance is just as important as mechanical maintenance, especially from the standpoint of safety, the provision of proper working conditions, as well as preventing the undue wasting of the assets of the company.

Lubrication

Since the keynote of modern maintenance is prevention, any discussion of this subject without at least briefly describing the importance of proper lubrication and its contribution to preventive maintenance would be inadequate. It is in the field of lubrication that real progress has been made in recent years.

A study of the causes of mechanical breakdowns will show that a very large number can be directly attributed to failure to supply adequate and proper lubrication. This does not necessarily mean that sufficient oil has not been used but it does mean that there was not sufficient oil at the points which required lubrication. The losses due to the failure to lubricate properly all the necessary points requiring lubrication, and the wastes resulting from the use of the wrong lubricant and the careless use of lubricants are enormous. In order to overcome these losses a number of things are being done:

> There is a distinct tendency in the direction of making lubrication as automatic as possible, thus eliminating the human element. By these improved methods of lubrication sufficient lubricant is forced under pressure to every point requiring it. There is no need for the worker to avoid oiling certain parts of the machine because they are difficult to reach. Machine manufacturers recognizing the importance of adequate lubrication are equipping their machines with these devices and many manufacturers are installing such systems upon the machines which they already have in their shops.
>
> The responsibility for properly lubricating machines is rapidly being taken from the machine operator, who frequently has proven unsatisfactory as an oiler, and is being centralized in the hands of a single individual, sometimes called a lubrication engineer who is responsible for the adequate lubrication of all machinery and equipment. With this centralization careful cost records are kept which prove valuable in the study of lubrication problems.
>
> A more careful study is being made of the lubricant to use in order to ascertain whether or not it will meet the purpose for which it is to be used.
>
> Lubrication surveys are being made in plants, as a result of which both the cost of oil and the cost of labor are being reduced.
>
> Lubrication is being scheduled and the oiler routed, time studied, and placed on incentive systems of wage payment with considerable success.

Without doubt one of the most efficient means of preventing mechanical failures of machines is supplying adequate lubrication.

Standing Order for Maintenance Department

After standards have been established for the maintenance of plant and equipment, as indeed for any phase of the business, the development of a standing order is an invaluable aid in maintaining that standard. The standing order for the maintenance department explains in detail the purpose of the maintenance department, its functions, and its method of operation. It serves as a means of placing before the members of the Maintenance Department the basic ideas behind maintenance work and in instructing them in the standard method of carrying out these ideas. As a device to aid in maintaining standards the standing order has been of no small importance.

It is not the purpose here to outline in detail the methods of operating a maintenance department charged with the maintenance of standards of plant and equipment, however, it is well to note that all of the principles of good management which apply to the various production units apply equally as well in the maintenance department. In the past, many maintenance engineers were wont to plead that their departments were different, that no two jobs were ever exactly alike and therefore those principles of good management which were applicable in shops manufacturing a standardized or nearly standardized article could not be applied by them. We are rapidly learning that good management is not limited in its application to any one department or series of departments and that it is just as applicable to the maintenance department with all its variety as it is to an actual producing department. For example, carefully developed organization with definite lines of authority and fixed responsi-

bility is as necessary in a maintenance department as in any activity. Records, carefully developed to suit the needs of the maintenance department, supply information which can be used in a most effective manner. Such records, for example, would be records of individual machines, giving their cost, facts about their capacity and use, location, etc., as well as a list of repairs made on each machine and the dates and cost of these repairs. These records give very valuable information with reference to the performance of every machine and often result in information leading to the redesign of parts, and are valuable in the purchase of new machines. Job study and the application of various types of incentive wage payment are being used in some maintenance departments and give evidence of good possibilities. Accurate information with reference to maintenance costs is being kept and maintenance budgets are being used in many companies. Maintenance work can be as successfully planned as the work of the average manufacturing department. While one still occassionally hears the old objections, setting forth the difficulties of maintenance management, there can be no doubt whatever that maintenance management has improved remarkably within recent years.

Table 2. Inspection Code[5]

Type of Tool	*Inspect for*	*Inspection Tools*
Arbors, mandrels, etc.	Freedom from scratches or flats, wear, condition of centers	Snaplimit gage, or micrometer
Clamping, bolts	Condition of thread, condition of nut	
Gages	Size	Master gages
Hammers	Condition of head, handle	
Lathe	Sharpness, soundness (freedom from cracks, chips, etc.), correctness of cutting angles, height of nose	Height gage, angle gage
Milling cutters	Sharpness, soundness	
Planer	Sharpness, soundness (freedom from cracks, chips, etc.), correctness of cutting angles, height of nose	Height gage angle gage
Reamers	Sharpness, soundness, size, condition of wrench shank	Micrometer or limit gages
Taps	Sharpness, wear, condition of shank	Screw gages
Twist Drills	Sharpness, condition of point, condition of shank	
Wrenches	Size of opening	Standard nuts

[5] Management's Handbook, page 585.

3

Maintenance of Tool Standards

In any discussion of the maintenance of plant and equipment it is desirable to emphasize particularly the importance of tool maintenance. This problem, after proper tool standards have once been established, involves a discussion of:

Tool inspection
Tool repair
Proper storage and control of tools

Tool Inspection

In order that the established standards of tools be maintained it is necessary that no tool be returned to its storage place in the tool room unless it has been first inspected. It is also necessary that all new tools which have been purchased, be carefully inspected in order to determine whether or not they meet the established standards. This inspection of tools is an essential portion of tool room operation and cannot be omitted if standards are to be maintained. A definite inspection code should be developed indicating what each type of tool is to be inspected for, and what inspection tools are to be used in making the inspection.

Tool Repair

Tools which cannot pass inspection should be repaired so that they will meet definitely established standards, before they are returned to their place of storage in the tool room. The tool repair department is usually operated in connection with the tool room. Tool repair should not be left to the workers in the shop.

Proper Storage and Control of Tools

One of the functions of the tool room is to supply the proper standard tools to the shop when required. In order to do this it is necessary that the tools be properly classified and stored in the tool room and that they be properly charged to the persons using them.

If tools are not maintained in standard condition, neither quantity nor quality work can be produced by the producing departments.

4

Maintenance of Quality of Standards

Present-day competition is forcing the production of a product whose quality is constantly being improved. Present-day production methods, involving the large use of interchangeable parts which must be assembled rapidly and without fitting along a moving assembly line, are

forcing the adoption of close manufacturing standards. Present-day management methods involving careful production planning, control of work, and the utilization of incentive systems of wage payment demand that quality standards be closely maintained.

In discussing the maintenance of quality standards, it is well to divide the discussion into a consideration of:

Maintenance of raw material standards
Maintenance of standards of material in process
Maintenance of standards of finished product

Maintenance of Raw Material Standards

Increasing numbers of manufacturers are using specifications for the purchase of materials and are carefully maintaining the standards set forth in the specifications by inspection upon the arrival of the material at the factory. In the case of materials as with any other standards, the standard is valuable only when it is properly maintained through careful inspection. In the report on Recent Economic Changes in the United States, the following statement is made with reference to this subject:[6]

> ". . . Buying upon specification and checking by testing laboratories has become the going practice. Most of the larger companies, and many of the smaller ones, have their own laboratories; and commercial laboratories are freely used by them as well as by those which cannot afford their own. Practically all managers report that they are increasing the precision of their specifications, which in the larger companies comprise several printed volumes. Some work out their own specifications, as must be done in special cases; but for the more staple items the large majority are using the published standards which leading trade associations have been active for several years in developing. The American Society for Testing Materials and the American Standards Association have had large shares in this development, and a considerable number of companies are using to an increasing extent the specifications of the United States Bureau of Standards."

As an example of the care which is being exercised in a number of plants to be certain that materials supplied are in accordance with established standards, the following example is given: in a full fashioned hosiery mill manufacturing a high grade product, the greatest care is taken to see that all materials are standard. In addition to the usual tests to which shipments of silk are subject, it is examined upon a seriplane, a machine having a black board upon which the silk is carefully wound one thread at a time, and no two threads upon each other. The black background upon which this silk is wound makes the evenness of the silk clearly visible. The appearance of the silk while wound on this board is compared with a standard card and the silk rated in a percentage figure. Unless the silk comes to the established standard for evenness it is rejected. In the same mill before silk is used in the plant, a sample is run through a series of machines and a careful record made of the number of times the thread breaks and the reasons for the breakage. These figures are tabulated for every lot of silk and unless the established standard is met the lot is rejected. The advantages of making these tests are evident from the standpoint of turning out a high quality product, free from imperfections caused by the use of poor material. Standard material also results in better labor relations inasmuch as the rates of pay are uniform and the wages are not dependent upon whether or not a good lot of silk is being worked upon.

[6] "Recent Economic Changes in the United States." McGraw-Hill Co., Inc., 1929. page 510,

Maintenance of Standards of Material in Process

Maintenance of proper quality standards of materials in process may be said to depend, at least in part, upon the following conditions:

Definite and reasonable quality standards
Supplying the worker with the proper materials, machines, tools, and equipment to perform the job, as well as the use of properly maintained measuring devices both by worker and inspector
The position of the Inspection Department in the organization and a proper consideration of where the ultimate responsibility for quality in an organization rests
The development of the idea of preventive inspection and the development of co-operation between workers and the inspection department

In setting up quality standards for manufacturers, those standards should be definite and fixed, and there should be no doubt in the mind of either the worker or the inspector as to what the standard is. The standard should also be reasonable and consistent with the conditions under which the work is to be done, and the purpose for which the article is to be used. The design and the engineering department in establishing standards can be of great assistance in this connection.

If proper standards of quality are to be maintained in the organization, it is desirable that the inspector should not report to an executive in the organization whose interest is primarily quantity rather than quality. Nor should the inspection department be looked upon as being alone responsible for the quality of product. The inspection department is merely the instrument for checking the quality of work produced in the organization to be certain that it comes up to the established standard, but the ultimate responsibility for maintaining and enforcing quality in an organization rests with the foreman and workers in the producing departments.

The maintenance of a high standard of quality in an organization is also to a high degree dependent upon the attitude of the inspector in enforcing quality. The idea of prevention in connection with inspection which was spoken of before is important here also. Instead of merely rejecting work which does not meet the established standard, the inspector should indicate the cause of rejection and take the necessary steps to have the cause remedied, so that it will not be the reason for future rejections. Unless this is done much poor work will be repeated when it could have easily been eliminated. Rejections are often caused by failure of workers to understand instructions, using wrong methods in performing operation, using machines and tools which have not been properly maintained. If the inspection department will act to remedy these conditions rather than merely reject work which does not meet the established standards, cooperation between workers and inspectors will result rather than the antagonism which now exists between these two groups in many organizations.

Maintenance of Standards of Finished Product

Maintenance of standards of finished product involves the same careful inspections which the maintenance of other standards requires. In some organizations at the present time this final inspection of product is performed by sales inspectors or what have been called in some organizations, consumer representatives, who are in no way connected with the production department and who have complete authority to reject whatever articles they desire. The basic idea behind this plan seems to be that a product may pass a factory inspection but nevertheless may still be unsatisfactory from a consumer's point of view. It is the purpose of this inspection to look at the product as a consumer would look at it, and decide whether or not the consumer would be pleased with it. In these days of severe competition, the product must not only be technically correct but it must also be attractive to the consumer.

5
Maintenance of Plan of Organization and Its Mechanism

The maintenance of plan of organization and its mechanism is a phase of maintenance of which one hears and reads very little, yet from the viewpoint of scientific management it is just as important as any other phase of maintenance.

After the plan of organization has been carefully studied and worked out, standards established, and routines developed, and the business placed in condition to function in a most effective manner, it has often been assumed that it will do so without any further attention. Experience has shown that this is not so. Unless the plan of organization and the mechanisms which were developed in connection with it, are constantly examined and inspected, members of the organization will gradually fall back into their old methods and the resulting condition is likely to be worse than the original one since the organization will now very likely be going through motions which will mean nothing. This slipping from the original plan will probably start by making so-called short-cuts, or improvements will be ill advised and probably will result from a failure to understand the purpose of the mechanisms which have been developed. This has occurred in many instances in which consultants have reorganized a business and then were not retained to follow up their work by regular inspections. In such cases, after the original installation is completed the consultants should be retained so that they will call from time to time to make certain that the plans of organization and mechanisms which they have devised for the particular company are being used as they should be used, and that there are no omissions or additions unless they have been carefully considered by the persons most familiar with the reasons for their original adoption or omission.

Taylor recognized the importance of this type of maintenance and constantly emphasized it in his writings. In his work "On the Art of Cutting Metals" he says:

> Even if these written instructions are sent to the machinist, however, little attention will be paid to them unless rigid standards have been not only adopted but *enforced* throughout the shop for every detail, large or small, of the shop equipment, as well as for all shop methods.

Again in "Shop Management" he says:

> Perhaps the most important part of the gang boss' and foreman's education lies in teaching them to promptly obey orders and instructions received not only from the

superintendent or some official high in the company, but from any member of the planning room whose especial function it is to direct the rest of the works in his particular line; and it may be accepted as an unquestioned fact that no gang boss is fit to direct his men until after he has learned to promptly obey instructions received from any proper source, whether he likes his instructions and the instructor or not, and even although he may be convinced that he knows a much better way of doing the work. The first step is for each man to learn to obey the laws as they exist, and next, if the laws are wrong, to have them reformed in the proper way.

It will be noted that Taylor did not say that if a standard were once established it should not be changed, under any conditions. He believed that if, after careful study, it could be shown that the standard could be improved then it should be changed, but it should only be changed by those who set the original standard and who are in a position to determine whether or not the suggested change is really an improvement or merely the desire of someone to have it changed for the sake of change.

Dr. Harlow S. Person well summarized the need for constant vigilance in maintenance in Chapter I of "Scientific Management in American Industry" when he said:

> The operations of an enterprise are the affairs of normal human beings and are subject to all influences of human nature—misunderstanding, inertia, inhibitions, carelessness, laziness. Training to do things according to a newly discovered "best way in the present state of the art" is a condition of learning with all the backslidings that result from the struggle between old and new patterns of conduct. A man may resolve to do a piece of work in a newly discovered best way with all the enthusiasm with which he resolves to grease and oil his new automobile precisely as set forth in the instructions; but six months later performance has declined from high resolve as badly in the one case as in the other—and for the same reasons.

Regular inspections are the method whereby the standards of organizations, mechanisms, procedures, etc., are maintained just as they are the means of maintaining standards in general.

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Conclusions

In this paper are included a discussion of the maintenance of only a few of the many standards which might have been considered. It has not been the purpose to consider in detail the technique of operation of any of the departments responsible for the maintenance of standards, but rather to consider the subject in a broad sense giving some of the fundamentals and problems involved.

To establish standards in an organization is to raise the level of performance in that organization. Whether the established level is to be maintained will depend upon whether or not the standards are maintained. Maintenance of standards acts very much as a ratchet, preventing the established standards from seeking a lower level.

If standards are to be maintained, responsibility for such maintenance must be definitely fixed in the organization, and a detailed technique developed for carrying out this responsibility.

The basic principle, upon which modern maintenance is based, is the prevention of variations from established standards by carefully planned inspections, the technique of which has been developed as a result of research and investigation. These inspections are carefully scheduled, according to the frequency necessary for effective control, and a tickler file maintained to be certain that the established schedule is maintained. In determining the type and frequency of inspection, its cost must be balanced against savings resulting therefrom.

If standards are to mean anything in an organization, and if they are to be properly maintained they must be reasonable working standards. From a practical point of view it is impossible to maintain standards which are unduly severe.

In the maintenance of all standards, standard practice instructions or standing orders are an invaluable aid, and their importance can hardly be over-emphasized. Every department responsible for the maintenance of a standard should develop a standing order covering its work setting forth its purpose, functions, and procedures.

Departments responsible for the maintenance of standards should exercise an influence in the direction of the development and improvement of existing standards. Through the work of inspection much valuable information will be obtained for this purpose.

The importance of maintenance of existing standards in an organization is as great as the importance of the standards themselves. Failure of proper maintenance means the loss to the organization represented by the difference between what should have been and what actually occurred. Without proper maintenance of standards scientific management could not exist as, without maintenance, there could be no

standards, and standards are the foundation of scientific management.

To the worker the establishment and maintenance of standards in a shop means a shop where the relations between management and men are likely to be good as an important cause of disputes is removed, especially if the worker is operating on piece work or an incentive system of wage payment.

Low-grade materials, lack of well-defined standards of quality, machines which are out of adjustment, poor working conditions, incentives based on standards which are not maintained cause no end of ill feeling between the men and the management.

Constant Vigilance Urged

One cannot over-stress the importance of constant vigilance in the maintenance of standards. Standards without maintenance are soon no standards at all, and their existence in the organization may prove most dangerous from the standpoint of shop operation and plant morale. L. C. Bryant in "Scientific Management in American Industry"[10] well stated the importance of the maintenance of standards when he said:

> Factory operation standards are of value only as long as they are maintained. It is a human characteristic to follow the line of least resistance and be satisfied with something slightly poorer than the best, and if this characteristic is allowed to act there will be a sloughing off in the quality of standards. With the fall of the standards comes a similar decline in accomplishment and personal responsibility. The cycle repeats itself until the condition of the standards reaches a level slightly lower than the desires of the man in a rut. Eternal vigilance is required to maintain standards.

There can be little doubt but that importance of the maintenance of standards is recognized more at the present time than at any time in the past, and that with the development of scientific management in the future even more attention will be directed to this important phase of management.

Dry Cells Standard Available

The American Standard, Specifications for Dry Cells and Batteries (C18-1930), approved in September, has been printed and is now available at fifteen cents per copy through the ASA Information Service.

[10] "Scientific Management in American Industry," page 226.

Economist Notes Effect of Standards on Retail Prices of Commodities

An interesting illustration of the effect of standardization upon price appears in the following quotation from an article by Professor Edgar Z. Palmer of the University of Kentucky in the New York *Journal of Commerce*. The paper in question deals with price comparisons which were made between chain and independent stores.

> "Some persons not agreeing with us that the store-wide representation is more important than standardization of quality in this kind of a study will be interested in Table II, which shows the effect of standardization upon the price differential. It seems from this table that the more highly standardized an article, the lower will be the chain store price relative to the independent store standard. On articles where quality plays an important distinguishing role, the chains do not seem to cut prices so drastically."

Ratio of Chain to Standard Prices for Standard and Non-Standard Commodities

Table II referred to in the preceding paragraph shows that the average ratio of all chain prices to standard prices on 22 commodities upon which brand was specified, absolutely standardized, is 82.8 per cent. On 14 staple commodities, relatively well standardized, the average ratio of all chain prices to standard prices is 86.4 per cent. The average ratio of all chain prices to standard prices on 22 other commodities, more difficult to standardize in quality, is shown to be 91.6 per cent.

In interpreting the above rather striking illustration of the effect of "standardization" upon price, it is only fair to point out that the standardization in question is not the thoroughgoing type employed in the preparation of uniform and recognized specifications, but the mass production uniformity of quality which develops due to concentration of demanu through national advertising. Nevertheless, the example holds as though true standardization were involved, since the consumer's buying behavior, resulting in the price relationships tabulated above, and manufacturers' and distributors' policies with respect to pricing, are based upon consumers' assumption that something akin to standardization, as the technician understands the term, has taken place in the establishment of a national brand.